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UNDERGROUND LONDON

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BY

JOHN HOLLINGSHEAD

AUTHOR OF "UNDER BOW BELLS," "ODD JOURNEYS," "WAYS OF LIFE," "RAGGED LONDON," ETC. ETC.

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PREFACE.

THIS book contains an account, more or less readable, of most things belonging to "Underground London," particularly of the mechanism of sewers, and of the water and gas supply. I have spared no pains to assure myself that my facts *are* facts, and I have too much respect for figures to use them in a loose or unreliable manner. I have waded many miles through old and new London sewers, have written a hundred letters, and seen a score or two of people, over and over again, often only to settle a question of a quantity, or a date. The first drafts of most of the chapters—excluding those which are mere compilations—appeared in *All the Year Round*, though they are here corrected and enlarged. The book would have been written precisely in its present form and style even if it had not first been filtered through the pages of a periodical.

I could scarcely have put together much of this volume if it had not been for the advice and help

of many more learned friends. Amongst these I must mention Mr. Bazalgette, Mr. Haywood, Mr. Grant, Mr. Cooper, Mr. Lovick, Mr. Cresy, Mr. Thwaites, Mr. Samuel Hughes, Mr. Thomas Spencer; the officers of all the water companies, and of some of the gas companies, and many other gentlemen possessing special information on "Underground London" topics. I have helped myself freely to all information contained in many blue-books on these subjects; and have often been directed in my few antiquarian searches by hints scattered so profusely through Mr. Peter Cunningham's invaluable *Handbook of London*.

JOHN HOLLINGSHEAD.

November, 1861.

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UNDERGROUND LONDON.

CHAPTER I.

DREAMS AND THEORIES.

THERE are more ways than one of looking at sewers, especially at old London sewers. There is a highly romantic point of view from which they are regarded as accessible, pleasant, and convivial hiding-places for criminals flying from justice, but black and dangerous labyrinths for the innocent stranger. Even now, in these days of new police and information for the people, it would not be difficult to find many thousands who look upon them as secret caverns full of metropolitan banditti. When the shades of evening fall upon the City, mysterious whispered "Open sesames" are heard in imagination near the trap-door side-entrances, and many London Hassaracs or Abdallahs, in laced-boots and velveteen jackets, seem to sink through the pavement into the arms of their faithful comrades. Romances, as full of startling incidents as an egg is full of meat, have been built entirely upon this underground foundation, and dramas belonging to the class which are known as "sensation" pieces, have been

placed upon the stage to feed this appetite for the wonderful in connection with sewers. I have some recollection of a drama of this kind that I saw some years ago at one of the East-end theatres, in which nearly all the action took place under huge dark arches, and in which virtue was represented in a good, strong serviceable shape by an heroic sewer-cleanser. Much was made of floods and flooding, which the flusher, who played the villain of the piece, seemed to have completely under his control; and it was not considered at all singular by the audience that a dozen men and women should be found walking high and dry under these mysterious arcades, as if in some place of public resort.

Imagination generally loves to run wild about underground London, or the sub-ways of any great city. Take away the catacombs of Paris—the closed, magnified, mysterious catacombs—and the keystone of a mass of French fiction falls to the ground. The dark arches of our own dear riverside Adelphi—familiarized, not to say vulgarized, as they have been by being turned into a thoroughfare to coal-wharves and halfpenny steam-boats—are still looked upon as the favourite haunts of the wild tribes of London, or City Arabs, whatever these may be.

A popular notion exists that those few sloping tunnels are a vast free lodging-house for hundreds of night wanderers; and that to those who have the watchword they form a passage leading to some riotous hidden haunt of vice. This belief prevails very largely amongst very quiet, respectable people;

the class who live in the suburbs, feed upon "serious" literature, shudder when the metropolis, the modern Nineveh, is only mentioned in conversation, and who, by no chance, ever heard the chimes at midnight, or were caught wandering about the streets after nine P.M.

The passion for dreaming about sub-ways, however, is not entirely confined to people who are totally ignorant of the existing out-door world. Hundreds of traditions are cherished about secret passages said to have extended from St. Saviour's, Southwark, under the river Thames, or from Old Canonbury House to the Priory at Smithfield. The people who cherish these traditions are not easily deceived by any fancy stories about life in London as it is now, they are too knowing for that; but they like to have their little dream of wonder about life in the middle ages. In vain does Mr. Roach Smith write, or do Archæological Societies lecture upon these fragments of old masonry, laid bare during the building of city warehouses or suburban settlements. The poor old monks are not to be saved so easily from a few damaging theories regarding their presumed habits, and the vestiges of ancient conduit heads, or covered ways to protect water-pipes,* are always thought to be the remains of murder-caverns, or cells for the unhappy victims

* The water-pipes used in old times were not always embedded in the earth as they are now, but enclosed within a capacious arch of brickwork, into which workmen could descend to repair any decay or accident.—*Ellis's History of Shoreditch.*

of religious hatred. A piece of ordinary rust, or of moist red brick, is soon pictured as the trace of blood; and those who do not take this sanguinary view of these unearthed sub-ways, are always ready to regard them as cellars full of buried gold.

Next to the romantic way of regarding sewers there is the scientific or half-scientific way, which is not always wanting in the imaginative element. I remember attending an exhibition, about four years ago, at the Society of Arts, which, although it consisted only of engineering plans for the improvement of London sub-ways, was amusing from the unpractical character of the schemes proposed.

A number of designs were submitted to the Metropolitan Board of Works for the total sub-surface reconstruction of the metropolitan streets, and these designs—about forty in number—were referred to a committee of eminent engineers, whose task it was to give away certain money prizes. Nearly all the designs, as far as I recollect, exhibited the same features: a centre tunnel under the roadway, accessible by traps from the street, and containing the different pipes for gas, water, telegraphic wires, and sewage. The plan that got a prize of one hundred guineas proposed to have arched brick vaults, extending from the houses on each side of the tunnel, giving a solidity to the roadway, and increasing to a great extent the cellar accommodation of houses and warehouses. Another plan, which got a prize of fifty guineas, had no central tunnel under the roadway, but provided for the

same purposes two side tunnels running parallel to each other, and connected with the houses on either side. The difference in the estimate of cost of the two plans was very great; the central tunnel scheme requiring something like thirty-six pounds sterling the lineal yard to carry it out; and the side tunnel scheme being estimated to cost only fifteen pounds for each lineal yard. As the latter plan had two tunnels to construct in the place of one, the great difference in cost must have arisen, if the calculations were correct, in the great area which the central tunnel projector proposed to build over with vaults. Many of the schemes exhibited were enlivened with pictures of the father of a family going down under the roadway in front of his house to see that the gas and water pipes were in proper order, and that no one had run away with the main sewer. A little more fancy on the part of the draughtsman might have represented whole parties of visitors inspecting the underground labyrinth as they would a conservatory at an evening party. Both the prize plans were regarded as very ornamental and excellent as pictures, but too expensive for practical application. The short central tunnel in King Street, Covent Garden, a pure experiment on the part of the Board of Works, undertaken, perhaps, to silence theorists, may appear to have been copied from the first plan; but, copied or not, it will probably be the only piece of fancy sub-way that London will see during the present century. The huddling together of gas

and water pipes and telegraphic wires on each side of the New Road, to make room for the Metropolitan Railway, is some approximation to the second plan, though very hurriedly and rudely carried out.

If we feel disposed to examine the scientific-theoretical way of looking at sewers, there is no lack of material, and we may be at once surrounded by almost as many "doctors" as we should find at a meeting held to denounce the Bank Charter. It is a peculiarity of theorists upon sewers and drainage that they nearly all pull in different directions. Their name is legion, but we should find it difficult to gather half a dozen of them together who would agree upon any consistent scheme of drainage. The two great plans that have occupied public attention for many years have been the purification of the Thames and the utilization of London sewage. It is easy to talk about a noble river being made the flowing cesspool of some *three hundred and sixty-three thousand inhabited houses* (according to the census of 1861) and of some two million eight hundred thousand inhabitants. It is easy to talk largely of ninety millions of gallons of sewage washed away every day through costly sub-ways by two hundred millions of gallons of rainfall, when they contain a daily fertilizing value of three hundred and sixty pounds sterling, or a sum that would reach more than one million pounds sterling by the end of a year. It is this muddy stream, trickling from innumerable house-tops, rushing down thousands of gullies, oozing through beds of gravel, draining off

marshy meadows and ploughed land, or flowing from thousands of dwellings, that helps to wash out the hundreds of downward sewers and their miles of tributary channels. This process of washing scatters and dilutes the valuable elements of fertility, until they are said to be lost beyond all hope of recovery. Men of science, capitalists, and social reformers, have consumed many years and much money in trying to restore this lost mass of valuable sewage to the hungry land, but nothing practical and remunerative, in a commercial sense, has ever been put before the public.

"Considerable works," says Mr. Austin, "of the most expensive kind, were constructed for distributing liquid, very nearly worthless as manure, over a district obtaining the valuable stable manure of the metropolis, at the most economical rate, by means of the return carts which convey to London the produce of the market-gardens, and which would otherwise return empty. In fact, practically, this was little more than a company for supplying the market-gardens of Fulham with water during periods of drought; and although, no doubt, a beneficial service, it will readily be imagined that the saving of labour of hand-watering over a limited district of garden-ground would produce no adequate return for so costly an establishment."

Messrs. Hofmann and Witt, the eminent chemists employed upon a report for the Government in 1857, give no very favourable opinion about the utilization of sewage.

"Everybody," they say, "admits the necessity of removing the daily excreta of so vast a population as that of the metropolis; of removing them rapidly, completely, and beyond the limits within which their decomposition would spread discomfort and disease.

"All admit, moreover, that the excreta of which we have to rid ourselves possess a very considerable value in an agricultural point of view, and that it would be highly desirable to recover the valuable matter.

"These points being granted, the question resolves itself into this:—Have we the means of accomplishing the latter desideratum, whilst satisfying the former condition?

"An inquiry into the nature of the valuable matter carried off in our sewers, an attentive examination of the chemical properties of the constituents, together with the consideration of the extraordinary and constantly-increasing degree of dilution in which they exist, cannot fail to impress the chemist, on purely theoretical grounds, with the magnitude of the difficulties which oppose themselves to the successful accomplishment of the task.

"Nor do these difficulties diminish if the question be submitted to the test of experiment.

"Notwithstanding the numerous proposals which have been made—notwithstanding the variety of patents which have been taken out,—we have no hesitation in stating our conviction that the *problem of profitably recovering the valuable constituents of sewage remains up to the present moment altogether*

unsolved; and very faint indeed are the hopes that the progress of chemical discovery will supply the means of so doing. The valuable constituents of sewage are like the gold in the sand of the Rhine; its aggregate value must be immense, but no Company has yet succeeded in raising the treasure.

"Nevertheless, on considering the immense value of the matter thus annually lost, and remembering that it nearly equals that of the whole quantity of guano imported annually into the United Kingdom, it would be unwise rashly to abandon this source of wealth without the most strenuous efforts to save at least a portion of it.

"The only chance that remains of accomplishing so desirable a result would appear, so far as we can at present judge, to consist in employing the whole or a portion of the London sewage for the purposes of irrigation.

"In devising, therefore, means for rapidly and effectually ridding the metropolis of the sewage, it is desirable that they should not exclude the possibility of giving this mode of utilization a fair trial.

"We have pressed the claims of the irrigation scheme in the accompanying Report, *not* because we are sanguine as to its success, but because of the numerous propositions which have been made for the profitable disposal of the London sewage, it appeared to us the only one which deserves seriously to be entertained.

"If a more thorough examination of this scheme should lead to its rejection—and we almost fear this

will be the case—if we have to give up the idea altogether of recovering the valuable constituents which are carried off in our sewers, then the Metropolitan Main Drainage Question, divested of one of its principal elements of complication, resolves itself into a problem, the solution of which belongs to the engineer alone."

We have been taunted with the superior wisdom of the despised Chinese, who have no elaborate underground sewage system, and who, instead of carrying away their floods of sewage wealth into the sea by tunnels built at the cost of millions of money, gather it every morning by public servants with more regularity than our dust is called for by the contractors, and take it away to nourish agriculture. Our reply to this taunt is, that people (adopting the vulgar superstition) who are as numerous as ants, and who have to live in boats because the land is too crowded to hold them with any comfort, must be often at their wits' end to procure food, and are, therefore, no models for a well-to-do civilized nation to copy.

The two chief plans put forward about thirteen or fourteen years ago to secure the sewage refuse as manure were both carried so far as to form two public companies with Acts of Parliament. The plan of one company was to collect the contents of some of the Westminster and Pimlico sewers, and convey them by a deep underground channel to Hammersmith, where a steam-engine and other machinery were to distribute the manure in a liquid

state to the market-gardens of that neighbourhood. The plan of the other company was to collect the contents of three main sewers falling into the Thames between Vauxhall Bridge and Westminster Bridge, and, after allowing the liquid part to flow into the Thames, to deprive the refuse of its offensive smell, and sell it as manure in a solid state. Both these projects fell through from their presumed commercial impracticability; but numberless plans and suggestions have, at different times, been brought before Government commissions, the old Commissioners of Sewers, the present Metropolitan Board of Works, and the City Commissioners of Sewers. Even no further back than 1857, when the great intercepting scheme of the Metropolitan Board of Works, which is now in rapid progress towards completion, was under discussion, about one hundred and forty different plans were sent in by well-meaning amateurs, competent engineers, and persons interested in the great sewage question. Some of these proposals naturally bore the well-known trade mark of Laputa, while others were almost practical in all their details—not quite. Without any wish to speak disrespectfully of sewage, I have a secret sympathy with old Sir Thomas Browne's feeling, and regard this daily mass of muck as a melancholy adjunct of our fallen state. Sewage, whether fluid or solid, mixed or unmixed, is very much like our convicts, everybody wants to get rid of it, and no one consents to have it. The hundred and forty gentlemen who kindly came forward un-

invited to suggest a method of purifying the metropolis, were compelled, in the main, to suggest that some selected spots should receive what London wished to reject. These spots were not Stratford-on-Avon, Windsor Park, the Crystal Palace, the South Kensington Museum, nor Belgrave Square, for very obvious reasons; but inferior settlements, inhabited by inferior people, in the inferior outskirts. Most of these unfortunate places showed no sign of indignation, because they were ignorant of the dark propositions for their defilement lurking in blue-books, or hinted at amongst the technicalities of a Government engineering report. One favourite proposition was to defile the sea, near the coast, and poison the great salt-water baths to which London resorts every summer for health and pleasure. Fortunately for the bathers the sea opposed these propositions in a quiet chemical way. The action of marine salts upon sewage—not to put it too scientifically—is so offensive, that fresh water must always be the first diluting agent employed before the whole mass is pumped into the sea.

Amongst the different schemes lately placed at the service of the country for intercepting and removing the London sewage, many proposed to divide the metropolis into sewage districts, and deal with the offensive material on true local self-government principles. One gentleman proposed to furnish each house with three iron tanks, hermetically sealed, in which the house sewage was to be collected each week, and then carried by drays to some

railway, and then by excursion trains thirty miles into the country. Another gentleman proposed similar tanks supplied with charcoal and ashes as deodorizing boxes; and another proposed the Chinese plan of preserving the sewage for certain companies, under penalties, which companies were to manufacture manure by boiling the sewage with clay or sawdust. Other projectors proposed to favour the mouth of the Kensington Canal, the bank of the river Lea, the Deptford Creek near Greenwich, and Battersea Creek, with four great divisional depôts, where the whole of the London sewage was to be conveyed and deodorized. Another gentleman proposed to bring half the southern sewage across the river at the Thames Tunnel, and the other half across the river in iron pipes, at some higher spot not specified, the material, when delivered, to be filtered, deodorized, and utilized. The peculiarity of this scheme was the bold proposal to defile the Thames Tunnel, and wake up this wonder of joint-stock credulity from its long sleep of idleness. Another projector proposed to favour Erith, Rainham, Wandsworth, and Putney with four great sewage-receiving depôts; or else to carry the whole mass to Newhaven, in Sussex, and throw it into the sea. Another gentleman suggested that the sewage should be collected from the houses and streets into large portable cisterns floating in the river, and that at stated times steam-tugs should call at each station and tow this unsightly fleet far out to sea to get rid of its contents. Several other gentlemen proposed

to moor vessels at the mouths of each of the existing sewers which run into the river (one hundred and eighty-five in number), and to connect the vessels with the sewers by means of iron or flexible pipes. The water of the sewage was to pass off by filtration, and the more valuable matter was to be left in the vessels. When they had loaded themselves, like milkmaids, at the sources of supply, these barks were to hawk their contents about at any ports where manure was likely to be in demand. No provision seems to have been made for back cargoes.

One gentleman wished to take the sewage away in iron vessels, and drop it quietly, when no one was looking, into the sea; while another gentleman, evidently thinking that criminals ought to suffer a little sewage infliction for their offences, proposed to form great deodorizing caverns from Blackfriar's Bridge to the House of Correction. Another projector proposed to deal with the mass as if it were gas or water, and to lay it on to the country in main and branch pipes. Several projectors hit upon this plan, and two proposed to carry it out by pumping the sewage up to a sufficient height to allow it to flow along pipes stretching in different directions into the country. Another projector suggested that the railways should be favoured with four great out-of-town main sewers running parallel with their lines of roadway. Another gentleman boldly proposed to cut the Thames in half, by diverting the stream from the river at Teddington

to afford a pure water-supply for London. The sewers were to be scoured by this diverted stream, and the sewage was to be removed by means of a tunnel, and emptied into the sea at Rochford, in Essex. The southern sewage was to be conveyed across the river to the north side at the Thames Tunnel; and the main feature of this scheme was to provide a river channel, up which the salt water should flow unadulterated to London. Another projector proposed to divide the Thames into tidal Thames and stream Thames, and to stop the sewage, by deodorizing works, from flowing into the river. Certain other projectors proposed to take one-half of the Thames Tunnel as a sewer for conveying the northern sewage to join the southern sewage. When combined, they suggested, like many others, that the whole mass should be taken to some point of the south coast and poured into the sea. One projector suggested that all communication between the sewers and the river should at once be cut off, and the sewage preserved for manure; and a lady —the one female projector amongst the number— proposed to have sewers stretching from all parts of London, from which the sewage could be poured in fertilizing streams all over the country on each side of the Thames. Her final reservoir was still the unoffending sea; and she proposed to construct small reservoirs, at convenient distances, along the sewers, which were to be opened as shops, where the farmers could call and purchase cheap liquid manure. Another projector, more fanciful than any

of his competitors, proposed to carry the sewage through the air by vast atmospheric tubes on both sides of the river, beginning somewhere about Putney, and terminating, as usual, in a great deodorizing reservoir on the sea-coast. Another projector proposed to construct two great sewers *under* the river Thames—a favourite but costly plan;—and another gentleman thought he could deodorize sewage, and ventilate the sewers by passing all the smoke of London into them. Another projector suggested that sewage should be first deodorized and then totally consumed by burning, and asked for Government aid to commence experiments on the power of fire to consume solid sewage. He suggested that Erith should be the locality favoured with these terrific experiments. Another projector proposed that the Thames should be purified by throwing into it about two thousand tons of chloride of sodium per week, which would cost about thirty-nine thousand pounds sterling per annum; another gentleman proposed to boil the sewage slightly, by way of deodorization, before it reached the sewers; and another projector suggested that the ordinary course of things should be reversed, and that instead of the Thames being flushed by the sewers, the sewers should be so altered that they should be flushed by the river.

Most of these plans, with a hundred others, are based upon an idea that the Thames would be converted into a crystal stream, if the sewage now flowing into it from nearly two hundred downward

main sewers could only be diverted. The plan which Mr. Bazalgette is now carrying out, as the engineer of the Metropolitan Board of Works, is certainly framed to divert this sewage by a system of intercepting and outfall sewers; but Mr. Bazalgette and Mr. Haywood, and even their Government opponents, never looked forward to such a purification of our noble river. There was a time, within the memory of our fathers, and not more remote than fifty years ago, when dozens of fishing punts were moored between the London bridges, and the fishermen, mostly amateurs, had no reason to be discontented with their hauls. In those days, if business was slack at the office, the warehouse, or the shop, or if the morning postman brought no letters that took more than an hour to answer, the old gentlemen used to take their hats, wink at their clerks as they passed out under the shallow pretence of keeping appointments, and slink down the winding alleys towards the river. At one of those little, brown shops, a few of which are still left as vestiges of a decayed trade, where a tapering rod hung out like a barber's pole, and a glistening stuffed fish over the low doorway, spun round like a doll at a marine-store with every breeze of wind, they called in for the tackle which they had not the courage to carry through Cheapside or Cornhill, and were soon pushed off by sympathizing watermen into the middle of the stream. Those were the days of Gravesend hoys; of a belief in long distances, and of five-shilling rowing fares to Chelsea; but with all

this peace and quietness, it is doubtful if the river was without stain and without reproach. It had nothing to do then with the refuse of the one million of people on its banks, for the cesspool system was strictly applied to houses, and the sewers conveyed nothing but rain and waste water. For all this, however, competent authorities decline to believe in its crystal clearness, and Messrs. Bidder, Hawksley, and Bazalgette, have said as much in their great report of 1858, on Metropolitan Main Drainage. "Within the metropolis," they say, "the Thames never could have been a 'silvery' stream. There can, indeed, be no doubt that if every particle of sewage were removed from the river, the Thames, as it now exists, with its rapid tide and its enormous traffic, must still remain a muddy water, differing but little in appearance from its present condition." The referees* themselves admit they do not anticipate that the Thames will present the appearance of a clear stream until the projecting headlands at the termination of every Reach shall have been protected from being washed away bit by bit.

"Several causes have contributed to the present condition of the river and of its banks. The removal of Old London Bridge has greatly augmented the tidal scour; the improved drainage of the land has brought down the upland waters with increased expedition after rainfall; thereby diminishing the quantity of water in the river in hot weather, and

* Messrs. Galton, Simpson, and Blackwell, Government Referees on the Metropolitan Main Drainage Scheme. 1857.

adding to the quantity of earthy matters conveyed by the floods. The agitation of the water by the action of steamboats, and the augmented velocity of the current induced by the removal of obstacles to the tidal flow. These operate to retain the mud in a state of suspension.

"The scour, the floods, and the agitation are the most influential contributors to the existing appearance of the river, and these will remain in operation and continue to produce like effects after the sewage shall have been withdrawn. We may, therefore, at once state, that the production of a clear or sensibly purified stream, in or near the metropolis, will prove a hopeless task, unless some powerful ruler shall in a future age determine to improve the appearance of the river at the expense of its commerce, by damming back the tide at Greenwich or Woolwich. Were there no population whatever existing on the Thames, the banks of the river, from its mouth to above the western limits of the metropolitan area, would, in the present condition of things, be covered with mud deposits, in consequence of tidal action alone, and the water remain almost as turbid as it is now."

This is rather a rude blow given to a thousand of those splendid dreams which are fed even by such muddy food as the London sewage. Turning our backs, to a great extent, upon sewer theorists and their theories, it may be well to make something like a stock-taking survey of underground London. Much capital has been sunk, year after year; much more

will have to be sunk; and many rate-payers may like to hear, in a gossiping way, what they have got for their money. The task of collecting this information and setting it forth is not quite so agreeable as a tour in Iceland; but some harmless drudges must do this parochial work, as some men must black boots, empty dust-holes, and sweep crossings. It is good sometimes to put the great epic, the great picture, or the great statue aside, and to walk round the parish pump with a desire to know something about it.

CHAPTER II.

GOSSIP.

If the poor old ghost of Dr. Johnson had not been so extremely hard worked of late years, it would be a pleasure to call it up (of course in connection with the ghost of Mr. Boswell), in order to get a satisfactory definition of a main sewer. The definitions of the great doctor may not always be conveyed in the most simple language, but then they come upon us with a full booming sound of undeniable authority. The boldest caviller never questions an opinion beginning "it is laid down by the great lexicographer," and hence the value of such an opinion on a subject surrounded by so many theorists, rival engineers, boards, and technicalities as sewers.

As we cannot avail ourselves of the doctor's defining wisdom, we must scramble through the entrance to our subject as we best can, and state, with no dogmatic precision, that main sewers are only properly so called when they follow the run of water-courses. This is a definition that most sewer engineers would not, perhaps, hesitate to endorse, and it shows us the natural, melancholy connection between "limpid streams" or "purling brooks," and black, slimy, muddy, underground rivers, that

no one ever thought of writing a sonnet to since poetry was born.

A volume of antiquarian sentiment might easily be written on the old London water-courses, or bournes. There is the ancient stream called Walbrook, which runs into the City, from what were once fields between Islington and Hoxton. In old times it turned a number of corn-mills, and even as late as 1810 it was found turning a lead-mill near the turnpike in the City Road. In its younger days, like all similar streams, it was spanned by many bridges throughout its course; and its lower end was wide enough to allow barges to be rowed up it as far as Bucklersbury to a spot now called Barge Yard. In 1489, the Lord Mayor gave two hundred marks towards vaulting it over near to the parish church of St. Margaret's, in Lothbury. This river discharged into the Thames east of Dowgate Dock. Its line within the old City wall and ditch was by Walbrook, Princes Street, crossing beneath the Bank and along Bell Alley to London Wall, and thence out of the City, across Old Street, to its source. It had several branches. Its bed was thirty-two feet beneath the present level of Princes Street, as was discovered when the London Bridge sewer—its great substitute—was built, and its waters have trickled under the foundations of the Bank. Even now, in its present dark obscurity, it has reason to be proud. It may consider itself the father of one of the lustiest young sewers in the metropolis; for the London Bridge sewer and its

neighbour, the Fleet, are the largest channels of underground London.

The Fleet itself—the "Turnmill Brook"—the "River of Wells"—bubbles up in a hundred volumes. It trickles through poems; forms little pools in plays; and sparkles, here and there, in less imaginative pages. Some historians of the Fleet Brook have regarded it with more veneration or enthusiasm than others, and have mused over its probable condition in the remotest times. They have pictured the period when Roman villas studded its banks; when Snow Hill was famous for its snowdrops; when Saffron Hill was a wooded slope like the Thames' banks at Richmond; and when the stream wandered down from its source in the Hampstead Hills, carrying swarms of silver trout into the Thames. They have dreamed over the time when large vessels may have floated up as high as King's Cross, where this black river is now carried over the underground Metropolitan Railway in an iron pipe or tunnel. Some excuse for this dream about an extinct inland river may be found in the tradition that an anchor was found some years ago as high up as the site of the Elephant and Castle, at Pancras Wash, where the road branches off to Kentish Town.

The Fleet Brook has always been celebrated for its periodical floods in winter. It is the most unruly sewer in the whole vast property handed over in trust to the Metropolitan Board of Works. In 1846 it burst its bounds, doing much damage to property

along its sides, particularly between Peter Street and Back Hill. Its embankment walls were much injured, three houses and a warehouse in Vine Street were thrown down, and a slaughter-house and mill-house were also undermined. The flood rose five feet in the houses which fell down, and in some places to the height of six feet above the pavement. Last winter it was impassable for many weeks; and thirty or forty years ago, after continued rains, or a sudden thaw with much snow upon the ground, it has often broken up its arches, and flooded the surrounding neighbourhood. A flood of this kind is recorded, which took place about 1820, when several oxen were drowned, and many butts of beer and other heavy articles were carried down the stream, from houses on the banks into which the water had broken. The greatest flood recorded in connection with the Fleet, during the present century, is one which happened in January, 1809. At this period, when the snow was lying very deep, a rapid thaw came on, and the arches, not affording a sufficient passage for the increased current, or storm-waters, the whole space between Pancras, Somers Town, and the bottom of the hill at Pentonville, was in a short time covered with water. The flood rose to the height of three feet in the middle of the highway; the lower rooms of all the houses within that space were completely inundated, and the inhabitants had much of their goods and furniture damaged which they had not time to remove. Two cart-horses were drowned, and for several days persons were

obliged to be conveyed to and from their houses, and to receive their provisions in at the windows, by means of carts. Much of the water of the Fleet Brook, originally drawn from springs on the south side of the hill between Hampstead and Highgate, by Ken Wood, where it forms several large ponds, has been carried off in pipes by the Hampstead Water Company (now merged in the New River Company) for the supply of the adjacent neighbourhood.

That portion or branch of the Fleet Brook down in the London valley, known by the unsavoury title of the Fleet Ditch, being part of the old town or City ditch, that ran round the walls for about two miles, is even more closely embanked with anecdote, history, and poetical satire. It was once supplied with the waters of certain local wells on each side of its course, such as Clerken-well, St. Chad's-well, Am-well, St. Pancras-wells, Bagnigge-wells, and others. It was also fed by a small brook, called "Old-bourne," the god-father of Holborn.

"Oldbourne, or Hilborne," says Stow, "broke out about the place where the Bars do now stand, and ran down the whole street till Oldbourne Bridge, and into the river of the Wells or Turnemill Brook. This bourn was likewise long since stopped up at the head, and in other places where the same has broken out, but yet till this day the said street is there called High Olborne Hill, and both sides thereof, together with all the grounds adjoining, that lie betwixt it and the river Thames, remain full

of springs, so that water is there found at hand, and hard to be stopped in every house."

The great fire of London stopped short in this direction at Holborn Bridge. The four bridges over the Fleet Ditch were Holborn Bridge, Fleet Lane Bridge, Bridewell Bridge, and Fleet Bridge. "After the great fire," says Mr. Cunningham, "Fleet Ditch was converted into a dock or creek, about forty feet in breadth, at a cost of about twenty-eight thousand pounds sterling, called the 'New Canal.' It was an unprofitable speculation. The toll was heavy, the traffic inconsiderable, and in spite of its new name and the money that had been spent upon it, the Ditch was doomed to continue a common sewer."

As early as Ben Jonson's days, the Fleet Ditch was considered a fair object for humorous satire and description. In the "Famous Voyage"—an account of an adventurous journey up the stream—the following passage occurs:—

> "All was to them the same; they were to pass,
> And so they did, from Styx to Acheron,
> The ever-boiling flood; whose banks upon,
> Your Fleet Lane Furies and hot cooks do dwell,
> That with still scalding steams make the place Hell;
> The sinks run grease, and hair of meazled hogs. . . .
> Cats there lay divers."

The Ditch was a nuisance in Cromwell's time, "by reason of the many encroachments thereupon made, by keeping of hogs and swine therein and elsewhere near it." As the "New Canal," with its sides built of stone and brick, its wharves and landing-places, it still maintained its repulsive character. Animals

seem to have fattened in its thick stream, to judge by the following passage in the "Gentleman's Magazine" for 1736:—

"A fatter boar was hardly ever seen than one taken up this day (August 24th, 1736), coming out of Fleet Ditch into the Thames. It proved to be a butcher's near Smithfield Bars, who had missed him five months, all which time he had been in the common sewer, and was improved in price from ten shillings to two guineas." A prodigal son, missing for this period, would probably have been reduced rather than increased in value.

Gay, in his "Trivia," has had a fling at the old Fleet Ditch:—

"If where Fleet Ditch with muddy current flows,
You chance to roam; where oyster-tubs in rows
Are ranged beside the posts; there stay thy haste,
And with the savoury dish indulge thy taste:
The damsel's knife the gaping shell commands,
While the salt liquor streams between her hands."

Of course, the oyster-shells were thrown into the "slow-creeping" stream, either by the stall-keeper or her customers.

Pope has added his mite to Fleet Ditch satire and history, in the "Dunciad:"—

"This labour past, by Bridewell all descend
(As morning prayer and flagellation end)
To where Fleet Ditch with disemboguing streams
Rolls its large tribute of dead dogs to Thames:
The king of dykes! than whom no sluice of mud
With deeper sable blots the silver flood."

Swift, with his usual bold felicity in dealing with such subjects, has outdone all his brother poets in his "City Shower:"—

"Now from all parts the swelling kennels flow,
And bear their trophies with them as they go;
Filth of all hues and odours seem to tell
What street they sailed from by their sight and smell.
They, as each torrent drives its rapid force,
From Smithfield to St. Pulchre's shape their course,
And in huge confluence joined at Snowhill ridge,
Fall from the Conduit prone to Holborn Bridge;
Sweepings from butcher's stalls . . . .
Drowned puppies, stinking sprats, all drenched in mud,
Dead cats and turnip-tops, come tumbling down the flood."

This nuisance was checked in 1734, by the Mayor and Corporation, who caused the Ditch to be arched over, from Holborn Bridge to Fleet Street. In 1765, when Blackfriars Bridge and Bridge Street were being built, another portion, from Fleet Street to the Thames, was arched over; and other portions have been arched or covered in at different times. The two old bridges which formerly spanned the Ditch at Holborn and Fleet Street, at the junction with Ludgate, are built into and form part of the present great sewer. Its length, within the City, is now about three-quarters of a mile, but it extends for miles beyond the City boundary, and drains an area of four thousand two hundred and twenty acres. Some few houses, at different parts of its course, still hang over the black, uncovered stream, like those old, traditional, bygone dens of Field Lane, which have been the source of a thou-

sand stories in the romance of crime. Jonathan Wild, Jack Sheppard, and other similar criminals, are said to have haunted this spot; and along with accounts of fat boars, City refuse, and coarse heroic couplets, we have many traditions of robbery and murder. Some of the houses overhanging the Fleet Ditch in the last century had trap-doors opening over the stream, through which many unsuspecting victims are said to have been thrust, as well as many heaps of muck and ashes. A small and dirty street, called Chick Lane, West Smithfield, was destroyed in 1844, when the memorable "Red Lion Tavern," in West Street, as the place was then called, was taken down. The house overlooked the open descent of the Fleet from Clerkenwell to Farringdon Street, and had long been infamous. It had many trap-doors, sliding panels, and cellars and passages for thieves; and a plank thrown across the sewer was often the means, it was said, of effecting an escape. A great crowd gathered round the place day after day, for several days, I being, on one occasion, amongst the number, and many stories were told and believed of murders and robberies hidden by the black flood below. The Fleet certainly rushed down to the river, in times of flood, and bodies picked up floating backwards and forwards with the tide, would, no doubt, have been taken ashore to be owned; and, if not owned, would have been buried by the parish with a Bow Street record of "found drowned." So far the machinery seems to have been well adapted for the commission of such crimes,

and we may therefore allow that a certain small percentage of the existing stories are possibly founded upon fact.

It is a relief to turn from these black or unsavoury records of one of the oldest and largest of the northern main sewers, to stories such as are told of the less famous Effra. This great southern sewer was once a small river, which, rising in the Norwood hills, flowed down in a winding course to Kennington, and then wound through South Lambeth to the Thames, near where Vauxhall Bridge now stands. "Forty years ago," says a contemporary writer, "nightingales in great numbers made their home in the sequestered portions of the Effra's banks, and flocks of larks might have been seen sweeping over Rush Common. The river was then wider than at present, with a current racing along faster than a man could walk. Although its channel was very deep, a day or two of heavy rain invariably caused an overflow, which laid South Lambeth, Kennington, and the lower portions of Brixton, under water."

The abbots of Merton had lands given them for the especial purpose of repairing the bridge over the Effra, at the point where Kennington Church now stands; and Brixton was once a happy hunting-ground, well stocked with game, where Queen Elizabeth used to disport herself, during her visits to Lord Norris. A local tradition exists that the strong-minded queen once came up the river Effra in her barge to visit Sir Walter Ralcigh, at old Ralcigh House, which still stands on the hill. Look-

ing at the partly open, partly closed black stream, which is now known as the "Wash," or Effra main sewer, and thinking of the frilled fulness which characterized the Elizabethan style of dress, it is difficult to believe that the former could have ever been broad enough to admit the latter. There, however, is the tradition; firmly rooted, like many other traditions, in the popular faith, and pictures are called up of gilded barges, the sweeping of light guitars, potato-custards, tobacco pastiles, and the chivalry that makes door-mats of velvet cloaks.

CHAPTER III.

HISTORY.

Most of the old water-courses can come forward with like stories of what they were in their younger days, when they were honoured as rivers, and not degraded into dark underground sewers. It must not, however, be inferred from this that our sewerage system, our drainage plans, and our sanitary theories are things of yesterday, based upon nothing but the well advertized civilization of the last twenty years. As early as the year 1290, the monks of Whitefriars complained to Parliament about the nuisance of the Fleet Brook. Their case was, that putrid exhalations of the thick stream overcame the frankincense burnt at the altar during the hours of divine service. At a Parliament held in 1307, Henry Lacy, Earl of Lincoln, also complained, "that whereas in times past the river Fleet had been of such depth and breadth, that ten or twelve ships with merchandise were wont to come to Fleet-bridge, and some of them to Old Borne-bridge, now, the same course, by the filth of the tanners, and such others, and by the raising of wharfs, is stopped up." The stream was frequently cleansed; and in the year 1502, the whole course of

the Fleet Dyke, as it was then called, was scoured down to the Thames.

The municipal organization for sanitary purposes which we now have in the Metropolitan Board of Works and the Sewer Committees or District Boards of the different London parishes, is the steady growth of five or six centuries. Every step in its progress may be clearly traced; from the signature of the Great Charter by King John, to the recent Act of 1855 for the better local management of the metropolis.

The aim of the earliest legislation was to preserve the uninterrupted flow of the natural watercourses, to remove existing obstructions, and to prevent their future growth; these objects are specifically provided for in the great charter—the first bill of sewers. This law was generally put in force by a petition to the crown, setting forth the grievance complained of. If the petition was entertained, some well-informed persons were selected, and entrusted with a commission empowering them to inspect the complaint and enforce the law against the offenders. The first commission of this kind on record, granted within the present metropolitan area, is one for Surrey and Kent, in the year 1295, some eighty years after the signature of the great charter.

These commissions, having no better rule than the local customs of each separate area of jurisdiction, soon felt the want of a more defined principle of action. Accordingly, Henry the Third, on occa-

sion of a complaint from the occupiers of Romney Marsh, sent down a very eminent judge, Henry de Bathe, who, after due examination of the most intelligent and able witnesses, drew up from their evidence a code, known as the Laws and Customs of Romney Marsh, in the County of Kent. They were revised and increased by successive judges, extended to all other marshes, especially those on the *Thames*, by Edward the First, and are cited as the rule of law in most subsequent commissions. These ordinances provide for a general survey and admeasurement of the whole marsh, and the banks* to be repaired; for the election of twenty-four jurats by the commonalty, who should apportion the duties and costs to each tenant, as well as of a bailiff, who should give him notice of his liabilities, execute the work in his default, and levy double the *cost* thereof upon his property.

The advantages of a steady and regular administration over the fitful action of bodies assembled for a temporary purpose, could not fail to be soon perceived; accordingly, Parliament, in the 6th of Henry the Sixth, A.D. 1427, considering the great damage caused by inundations in divers parts, and

* Although no records of the construction of the Thames embankments are accessible, those works are unquestionably of very ancient date; and, viewed as productions of engineering energy, are of a magnitude and extent which entitle them to be considered as the most remarkable, as they are certainly the most ancient, of any similar works in the kingdom. There is every reason to believe that they were constructed at a period contemporaneous with the Roman occupation of Britain.—*Report on Metropolitan Drainage.*

likely to ensue, ordained that the chancellor shall issue commissions of sewers during the next ten years, the form of which, though rather briefer, does not differ in any essential material from those issued down to the present day, and especially directs the members to make necessary ordinances according to the Laws and Customs of Romney Marsh, thus giving the crown-appointed commissions a Parliamentary sanction. Two years later, another Act of Parliament enabled the commissioners not only to make ordinances, but to execute them. In 1472, the nuisance of weirs and impediments continuing, a short act recapitulated and confirmed former acts for their removal, and enforced penalties on offenders.

The next step in sewer legislation was taken during the reign of Henry the Eighth, in the year 1531, in an act commonly known as the Bill of Sewers.

This act has served as the basis of later legislation, and was the only *general* statute till the passing of the Metropolitan Sewers Act of September 4, 1848. It recites the need of commissions of sewers, the form of commission, the oath and qualifications of its members, assigns them wages, empowers them to survey walls, streams, ditches, banks, gutters, sewers, bridges, mills, dams, ponds, locks, flood-gates, weirs, and other impediments, and to correct, repair, or amend them; to inquire by oaths of a jury where such annoyances are, and by whose default; to punish offenders, assess the persons con-

tributing to the charge, to appoint and pay keepers, bailiffs, surveyors, collectors, expenditors, and other officers, to distrain for arrears, to impress men, carts, horses, oxen, and implements, to take materials at their own valuation, to make ordinances, to hear and determine all causes arising out of or under the act, to issue writs and precepts to sheriffs and bailiffs, and to compel others to obey their orders. Each commission was to last three years, and the act to endure for twenty—but it was renewed and made perpetual in 1548—during the reign of Edward the Sixth.

During the reign of Elizabeth, in the year 1570, Parliament extended the commissions to ten years, gave their ordinances force after their expiration; and in the 3rd of James the First (the king who went into partnership with Sir Hugh Myddleton to supply London with water), extended their jurisdiction to all walls, ditches, banks, gutters, sewers, bridges, and water-courses, within two miles of the City, which fall into the Thames.

After the passing of this act, commissions were issued to the separate metropolitan districts; to Westminster in 1659, Holborn and Finsbury in 1683, and the Tower Hamlets in 1686. Some doubts having arisen as to their jurisdiction over new sewers, a clause was introduced into a general paving act within the bills of mortality in the year 1690, during the reign of William and Mary, enacting that all new sewers since the 12th of Charles the Second should be, to all intents and purposes,

subject to the commissions. Another act, passed in the reign of Queen Anne, gives them the same authority over copyholds which was before possessed over freeholds, and also empowers them to issue distress warrants.

From this time no general law increasing the powers of the commissioners appears to have been passed, although several local acts were obtained to amend and enlarge those conferred by the statute of Henry the Eighth. In Westminster and the Tower Hamlets the commissioners were not considered to have power to build new sewers, while in the City of London, Holborn and Finsbury, Surrey and Kent, they were considered to have full power for that purpose. All the acts were very defective for minor drainage. The earlier statutes did not in any way contemplate house drainage; and most of the local acts prohibited its discharge into the sewers, and enforced the construction of cesspools. In 1810 there must have been two hundred thousand cesspools in London; but in that year their increase was checked, in consequence of many mechanical improvements in connection with an enlarged water supply. It was not, however, until 1830 that their abolition was very marked. As some mitigation of the evil arising from those acts, overflow-drains from the cesspools were permitted; but in the greater number of cases, and in all the poorer parts of the metropolis, cesspools without overflows were the rule, and covered drains the exception.

The attention of Drs. Arnott, Kay, and Southwood Smith was forcibly drawn to the evils resulting from this state of things, when they were the medical officers employed by the Poor Law Commissioners in 1838. The House of Lords took the first step in the matter in 1839, by petitioning the crown for an inquiry and report to be made upon the physical causes of sickness and mortality, to which the poor are peculiarly exposed. The Poor Law Commissioners made a report; a commission to inquire into the state of large towns and populous districts was issued in 1843, and the Public Health Act was the result. The case of the metropolis had so many features peculiarly its own, that it was considered desirable to obtain further information before making it the subject of a new enactment, and accordingly, in 1848, the Metropolitan Sanitary Commission was issued, which reported at great length on the condition and defects in its administration. The practical result was to supersede all the separate commissions—Westminster, Holborn and Finsbury, Tower Hamlets, Poplar Marsh, Surrey and Kent, and Greenwich—and to consolidate them by issuing new commissions to the same individuals for all these separate jurisdictions. These commissions became fused into one by the Metropolitan Sewers Act of 1848—an important measure, that did not make any alteration in the principle of the law, but considerably extended the powers and authority of the commissioners, who were, however, still Crown-appointed. The area of jurisdiction was

extended to a circle of twelve miles' radius from St. Paul's, excluding the square mile, or thereabouts, contained in the City proper; all doubts as to the legal right to construct sewers were removed, all sewers were vested in the commissioners, and full power was given them over all private drainage. Their authority to make rates was defined and extended, and in place of the old troublesome qualification of a ratepayer, as one who received benefit or avoided damage, the principle was established of levying the rate over a certain definite area or district.

It is not necessary here to go into the history of the different Metropolitan Commissions of Sewers since 1848, until the creation of the Metropolitan Board of Works in 1855. The commissioners were often men of high scientific eminence, business talent, and well-earned popularity. They endeavoured to grapple with the great London drainage question, by inviting plans from competent engineers; and they were opposed by a plan brought before Parliament by Mr. Morewood in the years 1845 to 1853, which proposed to deal with the sewage by means of a public company, sharing profits with the ratepayers. The bill for this plan was lost; but in the different discussions and examinations of witnesses, the public were much enlightened on the subject of London drainage. So much opposition was shown to entrusting new sewer works of great magnitude and cost, for which the public would have to pay, to a limited Crown-

appointed commission, that Government, yielding to the expression of the general sentiment, infused a new element by the nomination to the new board of one local representative for each of the metropolitan boroughs. In 1855, the bill for the better local management of the metropolis became law, and, under its provisions, that sifted upper parish parliament, known as the Metropolitan Board of Works, came into existence. After six hundred and forty years of legislation, practice, and experience, the management of underground London and something more was handed over to a purely representative assembly. The changes effected by the Metropolitan Sewers Bill have already been adverted to; but much more extended powers are conferred by the Metropolis Local Management Act and its amendments.

The amount of rates leviable under the Sewers Act, has been successively one shilling, threepence, and sixpence in the pound; it is now *unlimited*. The rental of houses within the limits governed by the Metropolitan Board of Works, being the amount on which the rates are assessed, is now about fifteen million pounds per annum. The purposes for which such rates might be levied were confined to drainage only. The new acts comprise paving, cleansing, lighting, and improvements, the many details of street management, and the important duty of supervising all constructions formerly controlled by the Building Act. These powers above and below ground are exercised by a

corporation entirely parochial in its origin, which numbers forty-six members. These members are picked vestrymen, sent by their respective parishes to sit at the Metropolitan Board of Works; and as the vestries are elected by the ratepayers, the root of the sewer corporation is, or ought to be, representative. The City sends three members (in addition to having its own "Honourable Commissioners of Sewers"), the parishes of St. Marylebone, St. Pancras, Lambeth, St. George, Hanover Square, St. Mary, Islington, and St. Leonard, Shoreditch, send two each; a group of seventeen other metropolitan parishes, from Paddington to Woolwich, and from Camberwell to Hampstead, send one member each; and fourteen districts, including some fifty-five small or outlying parishes, send fourteen members more. No member can hold office, without re-election, more than three years, and once a year one-third of the members retire by lot. The chairman is chosen by a majority of his fellow-members, and may be turned out of office, at any time, by two-thirds of a special meeting convened to consider his appointment. His salary is fifteen hundred pounds a-year, but none of the members are paid, and he is assisted by a paid staff, chosen in a similar manner, consisting of secretary, engineers, solicitor, clerks, and messengers.

The Board came into its trust property when it started in business, and this property consists chiefly of the main sewers of the metropolis. These are now all marked, described, and mapped out, with

their numerous small tributaries, like valuable beds of coal; and it is to the preservation, enlargement, and improvement of these necessary veins of society that the energies of the Board are mostly directed. While the members labour, however, in a useful way, underground, they attend to ornamental work on the earth above. When the proprietor of a dwelling-house wishes to run out a Grecian portico—like a four-post bedstead—on to the pathway, the Board often objects to it as an obstruction; and as they are incorporated with power to sue and be sued (a fearful power!) their objection sometimes means mischief. They may alter the names of public thoroughfares, so that the staunch Whig who fancies he was settled for life in "Fox Place," may wake up one morning and find himself in "Pitt's Buildings." In checking the street obstructions, caused by opening the roadway for laying down gas-pipes, water-pipes, telegraphic wires, and even railways, they have a voice, and they are often exhorted to use it.

CHAPTER IV

OLD CHANNELS.

God bless the man who invented red-tape, and those who use it with judgment and discretion.

With all its admitted faults of architecture and street arrangement, London has the most elaborate system of underground sewerage of any city in the world. The work has been done piecemeal, at different times, and under the disadvantage, as we have just shown, of many separate commissions, rather than of one permanent board. The records of its construction are vague, scattered, and imperfect; and no amount of industry can dig up any pages of close, historical detail, such as would have been kept, as a matter of course, in a more despotic French bureau. Exception must be made to the records of the sewers in the City proper, and to some few of the parochial records; but the perfection of these is the result of individual care and industry, rather than of any recognized system. Vast tunnels of brick and pipe have been laid down in a rugged, representative way, and paid for by the ratepayers with the most wonderful uninquiring faith. Bills to the extent of millions sterling have been sent in to the public, met without the slightest hesitation,

and without any suspicion that the few gulley-holes at the street sides may be only show traps put forward for the sake of appearances. The spade and the trowel have not been idle, especially during the present century; but pen and ink have not followed close upon their footsteps. There has been a manifest stinginess in employing those recording angels—the humble clerks; and the consequence is, that the books of the sewer commissioners are very much like the accounts of a clumsy bankrupt. The trading certificates of these functionaries must be suspended for a few years longer, although there is no imputation on their honesty. Red tape may be objectionable when it interferes with the commencement of any work; but when the labour is completed, or even within certain limits during its progress, red tape is the life-blood of order and history.

The extent of underground London is, of course, very much modified by the extent of what in precise documents is called the metropolitan area. This area is always taken as being cut into north and south by the river Thames, and is divided into certain districts. On the north or Middlesex side of the Thames there are the western districts of Kensington, Chelsea, St. George's, Hanover Square, Westminster, St. Martin-in-the-Fields, and St. James's, Westminster; the northern districts of Marylebone, Hampstead, Pancras, Islington, and Hackney; the central districts of St. Giles's, Strand, Holborn, Clerkenwell, St. Luke's, East London,

West London, and the City of London; and the eastern districts of Shoreditch, Bethnal Green, Whitechapel, St. George's-in-the-East, Stepney, and Poplar. On the south or Surrey and Kent side of the Thames there are the districts of St. Saviour, Southwark; St. Olave, Southwark; Bermondsey, St. George's, Southwark; Newington, Lambeth, Wandsworth, Camberwell, Rotherhithe, Greenwich, Lewisham, and Woolwich.

These districts cover an area of one hundred and seventeen square miles, and according to the census of 1861, are filled with a gross metropolitan population of 2,803,034, spread amongst 362,890 inhabited houses. They are contained within that portion of the valley of the Thames which may be considered to commence where the high land approaches the river at Brentford on the north side, and at Richmond on the south side. The range of hills which bounds the valley on the north passes between Hanwell and Ealing, and then, turning eastward to Hampstead and Highgate, divides the valley of the Thames from that of the Brent. From Highgate the range continues in an easterly direction, separating the London basin from the tributaries of the River Lea, and is terminated abruptly at Stamford Hill, by the valley of the Lea.

On the southern side the range of hills which bounds the main valley may be considered to pass from Richmond, by Wimbledon Park to Tooting; then southward, by Streatham, Norwood, the Crystal Palace, Sydenham, and Forest Hill, to Deptford;

and to be terminated by the high land which passes south of Greenwich, and which abuts on the river at Woolwich. This main range of hills, however, is divided by three subsidiary valleys. On the east side of Richmond Park it is divided by the valley of the Bavely brook; between Wimbledon Park and Tooting it is again divided by the valley of the river Wandle; and again the valley of the river Ravensbourne, at Deptford, separates the main range from the high land which lies at the back of Greenwich and Woolwich.

The metropolitan district terminates in the marshes a little below Woolwich.

When considered with reference to drainage, the main valley of the Thames may be said to contain two distinct natural divisions—the upland districts, and the lowland or marshy districts. The upland districts are divided into a series of valleys, generally at right angles to the main valley of the Thames, or nearly so; and in each of these valleys is the bed of a stream,—one of the old water-courses,—which served to convey the natural drainage of the district towards the river.

The lowland, or marsh districts, on the other hand, present generally uniform surfaces, seldom much above, and usually several feet below the level of high-water. These districts appear to have been originally formed by enclosing the mud banks which skirted the river, the enclosed land being drained by ditches, with scarcely any inclination. The outfalls of these ditches are below the level of high-

water, and, therefore, the water they contain can only be discharged when the tide is low.

Through large portions of the metropolitan area these marsh districts lie between the upland districts and the river, and, consequently, the streams which convey the drainage of the upland districts discharge into the drains of the marsh districts, in which the water naturally remains stagnant for a portion of every tide.

When houses were first built over the metropolitan area, the streams and ditches retained their original functions as channels to convey away the rain-fall from the fields, roads, and roofs of the houses; water for domestic purposes, as we have before said, was not so largely used as it is at present, and the house drainage was collected in cesspools. "It was not," says Mr. Cunningham, "until after the great fire of London that water was conveyed down the side of the houses by leaden pipes. The drainage of the roof was ejected into the streets by clumsy spouts, just as griffins' mouths continue to convey the water from our cathedral leads, and men who cared for their clothes were watchful to keep the wall, and would push and fight for it with great pertinacity. The nuisances of a house, as late as the reign of Charles the Second, were placed in the street before the door, and the scavengers who removed the filth gave notice of their presence by knocking a wooden clapper. The sewage of a house was received into a well; and when the well was full the contents were pumped into the kennels of the street."

The first sewer in Chancery Lane was made by the Lord Keeper Guildford, in the reign of Charles the Second. That the Thames in those days was not considered to be without stain and without reproach, is proved by the following plan of a Mr. Wheeler (the proposed results of which are to be found in the Patent Office) for putting London, by land and water, thoroughly in order. In 1653 Mr. Wheeler sets forth a list of some works that he offers to undertake. He takes away the common loathsome discommodities of highways, and makes the most of them, the great roades within a mile or two of London, like pleasant promenades and walks of recreation, in all kinds of weather; from want whereof most great and faire cities may be deservedly called foule and unwholesome jakes and dunghills.

He undertakes to make the cittie of London a very faire, sweete, and pleasant cittie, within a week's time, so cleane within that one may walk in slippers in all weathers, except snow, in the foulest streets thereof, and can settle in a way whereby it may be preserved with lesse than half an hour's labour a day; so that houses scarce kept sufficiently clean with two servants, may by his discretion be put into condition with one; to the great preservation of clothes and shoeleather; the charge of scavengers shall be much lessened; the dirt shall be converted to other uses, and that water which foules the said river shall cleanse the land upon all occasions, and the water preserved in repositories or

cisterns; to run of themselves whithersoever the necessity of quenching fires calls them; and the confusion and waste of breaking up streets, opening water-pipes, shall wholly cease.

Hogarth's striking picture of a London night shows that manners had not much improved in the days of George the Second. It was not until 1849, according to Mr. Haywood, in his report upon the ventilation of sewers, that an organic change in our sewage system really took place. In 1848 the City Commission of Sewers obtained its act for sanitary purposes, which became operative upon the 1st of January of the following year. Then for the first time was a miscellaneous discharge into the sewers legalized; previously a penalty might have been enforced for such an usage of them.

This important change in the law, in the habits of the people since 1810, and in the system of drainage by which the house drains were compulsorily connected with the sewers, necessarily rendered the streams and ditches extremely offensive, and created the necessity of covering them over. The construction of sewers in the metropolis was also the means of abstracting and diverting large quantities of spring water flowing in the various strata through which the sewers passed. The absorption of water in all the sandy districts, and the loss of the celebrated springs at Bayswater, from which, in ancient times, water was conveyed to the city of London by leaden conduit-pipes in the direction of Oxford Street and Holborn, and some of which springs, in

the early part of the present century, formed the source of supply of the Stone Pipe, or Spring Waterworks, a company whose interest was purchased by the proprietors of the Grand Junction Waterworks, at the beginning of their career, are remarkable instances of the diminution of underground streams as the sewers have been extended through the metropolis.

When the Metropolitan Board of Works came into its property on the 1st of January, 1856, an inventory, in the form of a schedule, to the act of Parliament, set forth the titles and routes of the different main sewers of underground London handed over to the new corporation. There were fifty, including branches, on the north side, and twenty-one, including branches, on the south side; making a total of seventy-one, without counting the numerous alien branches which many of them gathered in in their course. These seventy-one underground channels thus became "main sewers" by act of Parliament; "a classification," says Mr. Haywood, "purely arbitrary, and made apparently upon no principle whatever." They all discharge into the Thames direct, with the exception of a few that reach that receptacle for all sewage by such roundabout channels as Hammersmith Creek, Deptford Creek, and the river Lea. These are not the only chief arteries of communication with the poor old Thames; and the following list will probably show the whole number, as near as we can ascertain:—

OUTLETS AND SLUICES ENTERING THE THAMES WITHIN THE METROPOLITAN AREA.

	North Side.	South Side.
From the River Lea to somewhere about the Thames Tunnel	20	25
„ the Tunnel to London Bridge	15	6
„ London Bridge to Blackfriars	23	6
„ Blackfriars to Westminster	36	3
„ Westminster to Vauxhall	4	2
„ Vauxhall to Battersea	15	4
„ Battersea to Fulham	5	3
North Side	118	
South Side	49	
Total	167	

We must add eight more outlets to this account for the sewers which run into the Thames on the north side within the city of London, and one hundred and seventy-five private outlets which exist within the same limits.

The main sewers handed over, in trust, to the Metropolitan Board of Works have an estimated length of one hundred and sixty-five miles; and the velocity of their currents varies from one to three miles an hour. The most important of them discharge, at periods of the day, in dry weather, from one thousand to two thousand cubic feet of sewage per minute, the greatest height being generally maintained during the hours of nine in the morning and five in the afternoon. At other periods of the day the same sewers rarely discharge more than one-fourth of this quantity. The following is a list of all these main sewers, with their respective

lengths, now published for the first time, and dedicated to all the ratepayers of the great metropolis. The intelligent ratepayer will, perhaps, be kind enough to consider that we are unrolling a panorama of underground London, beginning at Hammersmith Creek and winding round on the north side of the Thames until we come to the river Lea. On the south side we begin about half a mile above Putney town, and wind round by the river through Surrey and Kent, until we arrive at Deptford Creek. No length of sewer on the south side is said to be more than fifty years old.

MAIN SEWERS—NORTH SIDE OF THE RIVER THAMES.

Title.	Miles.	Feet.
Stamford Creek	4	3,830
Brook Green Sewer	3	1,810
Eel Brook Sewer	0	4,720
Fulham Sewer	0	1,660
Counter's Creek	8	3,780
Metropolitan Sewage Manure Works (3,410 feet of this common with Milman's Row, Queen Street, and Smith Street Sewers) -	2	1,900
Milman's Row Sewer (1,290 feet of this common with Metropolitan Sewage Manure Works)	0	2,810
Church Street Sewer	1	2,220
Queen Street Sewer (900 feet of this common with the Metropolitan Sewage Manure Works) ...	1	340
Smith Street Sewer (1,220 feet of this common with the Metropolitan Sewage Manure Works) ...	1	3,620
Ranelagh Sewer	9	3,595
King's Scholars' Pond—The Old Tyburn Brook ...	5	4,010
Grosvenor Ditch	0	1,820
Horseferry Road Sewer	0	2,350
Wood Street Sewer	0	2,080

Title.	Miles.	Feet.
Victoria Street Sewer	1	850
Regent Street Sewer	3	4,370
Northumberland Street Sewer	3	820
Savoy Street Sewer	1	4,320
Essex Street Sewer	1	4,510
Norfolk Street Sewer	0	2,530
Fleet Sewer	11	2,500
Goswell Street Sewer	1	3,220
London Bridge Sewer	9	3,340
Irongate Sewer	0	4,650
Nightingale Lane Sewer	1	1,720
Hermitage Street Sewer	*0*	*1,210*
Old Gravel Lane Sewer	*0*	*490*
Wapping Wall Sewer	*0*	*2,440*
Pennington Street Sewer	0	4,900
Ratcliffe Highway Sewer	5	4,640
Limekiln Dock Sewer	3	2,280
Blackwall Sewer	1	2,300
East and West India Dock Sewer	0	4,950
Great Barnfield Sewer	1	1,250
Drunken Dock Sewer	0	5,250
Eastern Counties Railway Sewer	1	820
Hackney Brook	9	5,020
	105	3,825
Deduct 3,410 feet common to Metropolitan Sewage Manure Works, and other Main Sewers ...	0	3,410
Total	105	415

MAIN SEWERS—SOUTH SIDE OF THE RIVER THAMES.

Title.	Miles.	Feet.
Beverley, or Bavely, Brook (5,800 feet outside the limits of the Metropolitan Local Management Act, not included)	3	920
Parish Boundary Sewer	1	1,500
River Wandle (10,300 feet outside the limits of the Metropolitan Local Management Act, not included)	4	1,180

Title.	Miles.	Feet.
Falcon Brook	3	350
Lord Spencer Sewer	1	3,100
Heathwall Wall Sewer	3	1,800
Effra Sewer	7	4,000
Dover Street Sewer	0	2,100
Arnold Street Sewer	0	4,000
Battle Bridge (Southwark) Sewer	6	4,020
Duffield Sewer	11	720
Limekiln Sluice	0	1,150
Durand's Wharf Sewer	0	4,550
Globe Stairs Sewer	0	500
Rotherhithe Pier Sewer	0	1,915
Earl Sewer	7	4,510
Royal Dockyard Sewer	0	1,600
Horseferry Road (Greenwich)	0	1,864
Ravensbourne and Sydenham	3	3,690
Ravensbourne and Lee Green	2	2,470
Total	59	3,699
Length of Sewers—North Side ... 105	415	
South Side ... 59	3,699	
Grand Total ... 164	4,114	

To this list should be added these sewers within the City—Whitefriar's Dock, Paul's Wharf, Hambro' Wharf, Dowgate Dock, Custom House, east and west, Wool Quay, and Tower Dock, the combined length of which, within the City, is nearly two miles. Three of these sewers—the Whitefriar's Dock, Dowgate Dock, and Paul's Wharf sewers, like the Fleet and London Bridge sewers—extend beyond the City.

Mr. Bazalgette, in one of his most recent reports (June 29th, 1861), speaking of the one hundred and sixty-five miles of legally constituted main sewers,

says: "Of these sewers one hundred and twenty-five miles require to be covered or reconstructed, at an outlay of about half-a-million sterling. The prevailing reason why so little has been done to place them in a more efficient condition has been that the districts which, under the present state of the law, would become chargeable for the cost according to benefit, object to such local impost; and the Board have postponed these improvements until they shall be entitled to charge the cost of these works generally over the whole metropolis."

The old open Hackney Brook sewer, he tells us in the same report, is now no more, its lower end having been replaced by the northern high-level intercepting sewer, which we shall touch upon in another chapter. The old Hackney Brook had become a sad nuisance in its old age, but in its youth it was a clear river, and was connected with the glories of the Roman occupation of Britain. It would be easy to get melancholy in musing over these records, and to fancy the time when the Rhine may be converted into a sluggish German sewer, or the Mississippi into a lively but offensive American ditch.

The length of the various channels running into these great tunnel main arteries, and completing the sewerage network of underground London, may be roughly estimated (including the main sewers) at sixteen hundred miles. Some of these channels are "private sewers," that neither central nor district Boards consider themselves bound to repair,

maintain, and father; some are old, diseased, decayed channels, known amongst the workmen as "dead" sewers; some are winding, egg-shaped channels, under the control of vestry sewers' committees; and most of them are broad, arched channels, pouring black Niagara streams into the dark, Thames-seeking flood.

CHAPTER V.

A DAY BELOW.

BLUE-BOOKS on sewers, like most blue-books, are very solid, instructive volumes, not half as much appreciated as they deserve to be, and too often made the easy butt of mechanical, uninquiring ridicule. Able, friendly sewer engineers and obliging secretaries are always crammed to overflowing with special information, and are always ready to be tapped to enlighten the public. Reports, pamphlets, letters, hints; cyclopædias that are learned upon cloacæ in general, and enthusiastic about the Roman Cloaca Maxima in particular, with a dozen other similar documents and publications, are not to be despised; but in dealing with underground London as if determined to know something about it, there is nothing like a long, sloppy, muddy, "mud-larky" survey. The great Charter itself, as we have before stated, provided for a survey, and King John's barons are generally considered to have known what they were about.

Feeling a desire to inspect a main sewer almost from its source to its point of discharge into the Thames, I applied to the proper authorities, and was obligingly told that they had not the slightest

objection to gratify what they evidently thought a very singular taste. I was even asked to name my sewer. They had blood-sewers (a delicate article) running underneath meat-markets, like Newport Market, where you could wade in the vital fluid of sheep and oxen; they had boiling sewers, which were largely used by sugar-bakeries, where the steam forced its way through the gratings in the roadway, like the vapour from the hot springs in Iceland, and where the sewer-cleansers get something very like a Turkish bath at the expense of the ratepayers. They had sewers of various orders of construction; egg-shaped, barrel-shaped, arched, and almost square; and they had sewers of different degrees of repulsiveness, such as those where manufacturing chemists and soap and candle-makers most do congregate. They had open rural sewers that were fruitful in watercresses; and closed town sewers whose roofs are thickly clustered with what our scientific friends call "edible fungi." The choice was so varied that it was a long time before I could make up my mind, and I decided, at last, upon exploring the King's Scholars' Pond Sewer, which commences in the Finchley Road and ends in the Thames a little above Vauxhall Bridge.

If the literary executors of the late Mr. Leigh Hunt had not cut the ground from under me in the title of a book just published, I might possibly have called this chapter A Saunter through the West End. We have all our different ways of looking at London. The late Mr. Crofton Croker had his way,

as he has shown in his "Walk from London to Fulham," and I have got mine. The man who starts, like I do, by regarding the Thames only as one vast cesspool, and by looking upon human beings only from the cubic feet per head of sewage point of view, must often take the arms of a few sewer-flushers in a friendly way, and keep up his dignity by thinking of Magna Charta.

Sewer-cleansers are a class of workmen who seldom come prominently before the public, perhaps because their labour is chiefly underground. They have never made any particular noise in the world, although they receive in London every year about five-and-twenty thousand pounds sterling of the public money. Their wages, individually, average about a pound a week. They have never distinguished themselves by producing any remarkable "self-made men;" any Lord Chancellors, or even Lord Mayors; and have never attempted, as a class, to "raise themselves in the social scale." They are good, honest, hard-working every-day labourers, who often meet extreme danger in the shape of foul gases, and sometimes die at their posts, as we saw the other day in the Fleet Lane sewer.

Some half-dozen of these men, with a foreman of flushers, attended upon me on the day I selected for my underground survey. They were not lean, yellow men, with bent backs produced by much stooping, and hollow coughs produced by breathing much foul air. Their appearance was decidedly robust, and as I measured bulk with one or two of them,

I had no reason to be proud of my supposed superior training.

There seems to be only one costume for underground or underwater work, and the armour necessary for sewer-inspecting will do for lobster-catching on the coast, or for descending in a sea diving-bell. The thick worsted stockings coming up to the waist, the heavy long greased boots of the "seven league" character, the loose blue shirt, and the fan-tailed hat, may be very hot and stifling to wear, but no sewer-inspector is considered properly fortified without them.

As I have before remarked, there is a fatal fascination about sewers, and whenever a trap-door side entrance is opened, a crowd is sure to gather about the spot. The entrance to the King's Scholars' Pond Main Sewer, that I decided to go down by, is close to the cab-stand at St. John's Wood Chapel, and twenty cabmen were so much interested in seeing me descend with my guides, that the offer of a fare by any passer-by would have been resented as an annoying interruption. My guides were not at all clear as to my motives for taking this underground "saunter through the West End," and the cabmen were even more hazy on this point than the guides.

"Rather him than me; eh, Bill?" said one.

"That licks cab-drivin'," said another, in reply.

The side entrance is a square brick-built shaft, having a few iron rings driven into two of its sides. These rings form the steps by which you ascend and descend, putting your foot on one as you seize

hold of another. I felt like a bear in a pit at the Zoological Gardens, as I descended in this fashion; and I dare say many respectable members of parochial sewers committees have gone through the same labour, and have experienced the same feeling. Before the iron trap-door over us was closed by the two men left to follow our course above ground, I caught a glimpse of a butcher's boy looking down the shaft, with his mouth wide open. When the daylight was shut out, a closed lantern was put in my hand; I was led stooping along a short yellow-bricked passage, and down a few steps, as if going into a wine-cellar, until I found myself standing knee-deep in the flowing sewer.

The tunnel here is about six feet high, and four feet broad; growing gradually larger, except near the canal in the Park Road, as it descends in a winding course towards the Thames. All main sewers may be described roughly as funnel-shaped; the narrow end being at the source in the hills; the broad end being in the valley, where it discharges into the river. The sizes of these underground tunnels, at different points of their course, are constructed so that they may convey the waters flowing through them with no prospect of floods and consequent bursting, and yet with no unnecessary waste of tunnelling. Here it is that the science of hydraulic engineering is required.

Turning our face towards the Thames we waded for some time, in a stooping posture, through the sewer, three of my guides going on first with lan-

terns, and two following me. We passed through an iron tube, about three feet high and two feet broad, which conveys the sewage over the Regent's Canal, through the crown of the bridge. It was not until we got into some lower levels, towards Baker Street, that the sewer became sufficiently large to allow us to stand upright.

Before we had arrived at this point I had experienced a new sensation. I had had an opportunity of inspecting the earthenware pipe drainage—I am bound to say, the very defective pipe drainage—of a house that once owned me as a landlord. I felt as if the power had been granted me of opening a trap-door in my chest, to look upon the long-hidden machinery of my mysterious body.

When we got into a loftier and broader part of the tunnel, my chief guide offered me his arm, an assistance I was glad to accept, because the downward flood pressed rather heavily against the back of my legs, and the bottom was ragged and uncertain. I could not deny myself the pleasure of calling this chief guide Agrippa, because Agrippa is a Roman name, and the Romans have earned an immortality in connection with sewers. Whatever doubts the sceptical school of historians may succeed in throwing upon the legends of Roman history, they cannot shake the foundations of the Roman sewers. Roman London means a small town, bounded on the East by Walbrook, and on the West by the Fleet. You cannot touch upon sewers without coming upon traces of the Romans; you cannot

touch upon the Romans without meeting with traces of sewers. The most devoted disciple of Niebuhr must be dumb before such facts as these, and must admit that these ancient people were great scavengers, if they were not great heroes.

Agrippa took a real pleasure in pointing out to me the different drains, private sewers, and district sewers, that at intervals of a few yards opened into our channel through the walls on either side.

"We've nothin' to do with the gover'ment of any of these," he said; "they are looked after, or had ought to be looked after, by the paroch'al boards."

"You look after branches?" I replied.

"Only when they're branches of prop'ly construed main sewers. We," he continued, and he spoke like a chairman, "are the Metropolitan Board of Works, and we should have enough to do, if we looked after every drain-pipe in London."

"What's the length of those drain-pipes all over London," I asked, "leaving out the sewers?"

"No one knows," he said. "They do tell me somewhere about four thousand miles, and I should say they were all that."

We went tottering on a little further, with the carriages rumbling on the roadway over our heads. The splashing of the water before and behind us, as it was washed from side to side by our heavy boots, and those of our guides, added to the noise; and when our aboveground followers let the trap-door of some side entrance fall, a loud booming sound

went through the tunnel as if a cannon had been fired. The yellow lights of the lanterns danced before us in front, and when we caught a glimpse of the water we were wading in above our knees, we saw that it was as black as ink. The smell was not at all offensive, and Agrippa told me that no man, during his experience in the London sewers, had ever complained of feeling faint while he moved about or worked in the flood; the danger was found to lie in standing still. For all this assurance of perfect comfort and safety, however, my guides kept pretty close to me; and I found out afterwards that they were thus numerous and attentive because the "amateur" sewer inspector was considered likely to drop.

"There," said Agrippa, pointing to a hole at the side, down which a lot of road sand had been washed, "that's a gully-trap. People get a notion that heavy rains pour down the gutters and flush the sewers; for my part, I think they bring quite as much rubbish as they clear away."

At different parts of our course we passed through the blue rays of light, like moonlight, that came down from the ventilator gratings in the highway above. Under one of these we heard a boy whistling in the road, and I felt like Baron Trenck escaping from prison. Some of these gratings over our heads were stopped up with road rubbish, and Agrippa, who carried a steel gauging-rod, like a sword, in his hand, pierced the earth above us, and let in the outer light and air.

"They're nice things," he said, alluding to the ventilating gratings, generally set in the top of a shaft-hole cut in the crown of the arch. "I remember the time when we'd none of those improvements; no side entrances, no nothing. When we wanted to get down to cleanse or look at a sewer, we had to dig a hole in the roadway, and sometimes the men used to get down and up the gully-holes to save trouble."

"You must have had many accidents in those days."

"Hundreds, sir, were suffocated or killed by the gas; but since Mr. Roe* brought about these improvements, and made the sewers curve instead of running zigzag, we've been pretty safe."

The "gas" alluded to by Agrippa is carburetted hydrogen, sulphuretted hydrogen, and carbonic acid gas. The first is highly inflammable, easily explodes, and has frequently caused serious accidents. The second is the gaseous product of putrid decomposition; it is slightly inflammable, and its inhalation, when it is strong, will cause sudden death. The third is the choke-damp of mines and sewers, and its inhalation will cause a man to drop as if shot dead. These are the unseen enemies which Agrippa and his fellows have constantly to contend against, more or less.

As we staggered further down the stream, it was evident that Agrippa had his favourites amongst

* The late Mr. Roe, for many years surveyor to the Holborn and Finsbury Commissioners of Sewers.

the district sewers. Some he considered to be "pretty" sewers; others he looked upon as choked, winding channels, not fit to send a rat up to cleanse, much less a Christian man. Looking up some of these narrow openings with their abrupt turns, low roofs, and pitch-black darkness, it certainly did seem as if sewer-cleansing must be a fearful trade. The sewer rats, so much talked of aboveground, were not to be seen; and their existence in most of the main sewers is a tradition handed down from the last century. They only abound in what are called the "blood-sewers,"—those under slaughter-houses and meat-markets; but the proportion of animal matter which they consume is probably not more than one-twentieth of that which finds its way down such channels. Though the surveyors try in every way to prevent the offal from slaughter-houses going into the sewers, it is nevertheless often thrown in, and the channels become obstructed in consequence. Hair often clogs up those sewers which are deficient in fall, and proves one of the most serious obstructions with which sewer-cleansers have to deal. Since the improved supply of water, however, which gives to every dweller in London, man, woman, and child, a daily allowance of thirty gallons per head, the rats and the hair have been largely washed away by the increased flood.

Although underground, we passed over the Metropolitan Railway in the New Road, and then along the line of Baker Street, under Oxford Street, and through Berkeley Square. This aristocratic neigh-

bourhood was loudly announced to us by our above-ground followers down an open "man-hole;" but there was nothing in the construction of our main sewer, or in the quality of our black flood, to tell us that we were so near the abodes of the blest. Looking up the "man-hole," an opening in the road, not unlike the inside of a tile-kiln chimney, down which some workmen had brought a flushing-gate, I saw another butcher's boy gazing down upon us with his mouth wide open.

The flushing-gate was an iron structure, the exact width of the sewer, and about half its height. These gates are fixed on hinges at the sides of all the main sewers, at certain distances from each other; and when they are closed by machinery, they dam up the stream, producing an artificial fall of water, and so scouring the bed of the sewer.

As we got lower down our great underground channel, the roof became higher and higher, and the sides broader and broader; but the flooring, I am sorry to say, became more jagged and uneven. The lower bricks had been washed out, leaving great holes, down which one or other of my legs kept slipping, at the hazard of my balance and my bones. We peeped up an old red-bricked, long-disused branch sewer, under some part of Mayfair, that was almost blocked up to the roof with mountains of black, dry, earthy deposit. Not even here did we see any traces of rats, although the sewer was above the level of the water in our main channel. The King's Scholars' Pond, so Agrippa told me, has had

five feet of water in it, at this point, during storms; but this was not its condition then, or we should hardly have been found wading in it. The bricks in this old Mayfair sewer were as rotten as gingerbread; you could have scooped them out with a teaspoon.

In Piccadilly we went up the side entrance, just to get a mouthful of fresh air, and a glimpse of the Green Park, and then went down again to finish our journey. I hardly expect to be believed, but I must say that another butcher's boy was waiting with open mouth, watching every movement we made with intense interest.

We had not proceeded much further in our downward course, when Agrippa and the rest of the guides suddenly stopped short, and asked me where I supposed I was now? I thought the question quite unnecessary, as my position in the sewer was pretty evident.

"We don't mean where are you in the sewer," said Agrippa, "but what's above your head?"

"I give it up," I replied.

"Well, Buckingham Palace," was the answer.

Of course my loyalty was at once excited, and, taking off my fan-tailed cap, I led the way with the National Anthem, insisting that my guides should join in chorus. Who knows but what, through some untrapped drain, that rude, but hearty underground melody found its way into some inner wainscoting of the palace, disturbing some dozing maid of honour with its mysterious sounds, and making her

dream of Guy Fawkes and many other subterranean villains? Before I leave this deeply-interesting part of the King's Scholars' Pond Sewer, I may as well say that I am fully alive to its importance as the theatre of a thrilling romance. That no writer of fiction may poach upon preserves which I have made my own, I will state exactly what kind of story I intend to write, as soon as I have got rid of a row of statistics that are beckoning to me in the distance. My hero will run away with one of the Royal Princesses down this sewer, having first hewn a passage up into the palace through its walls. The German Prince, who is always going to marry the Royal Princess, whether she likes him or not, will be murdered in mistake by a jealous sewer-flusher, the villain of the story; and the hero, having married the Princess at some bankside church, will live happily with her ever afterwards, as a superintendent of one of the outfall sewers. If this story should meet with the success I anticipate, I promise to raise some memorial tablet in the sewer under the palace, to mark my gratitude and the royalty of the channel. If any reader thinks the mechanical part of this story impossible, let me tell him that two friends of mine once got into the vaults of the House of Commons through the sewers.

Soon after we left this spot, we came upon a punt that had been poled thus far up the stream to meet us, and carry us down to the Thames. I took my seat with Agrippa, while the other guides pushed at the sides and stern of the boat, and I

thought this was a good time to put a few questions to the men about the treasures usually found in the sewers. The journey was wanting in that calmness, light, and freshness which generally belong to boat voyages, and while there was a good deal of Styx and Charon about it in imagination, there was a close unpleasant steam about it in reality. Still, for all this, it furnished an opportunity not to be thrown away, and I at once addressed Agrippa.

"Well," he said, "the most awful things we ever find in the sewers is dead children. We've found at least four of 'em at different times; one somewhere under Notting Hill; another somewhere under Mary'bone; another at Paddington; and another at the Broadway, Westminster."

"We once found a dead seal," struck in one of the men pushing the boat.

"Ah," continued Agrippa, "so we did. That' was in one of the Westminster sewers—the Horse-ferry Road outlet, I think, and they said it had been shot at Barnes or Mortlake, and had drifted down with the tide. We find musheroons in great quantities on the roof, and icicles as well growing amongst 'em."

"Icicles!" I said; "why, the sewers are warm in winter. How do you account for that?"

"I don't mean what *you* call icicles," he replied. "I mean those white greasy-looking things, like spikes of tallow."

"Oh, stalactites," I said.

"Yes," he answered, "that's the word. We

sometimes find live cats and dogs that have got down untrapped drains after house-rats; but these animals, when we pick 'em up, are more often dead ones."

"They once found a live hedgehog in Westminster," said another of the men. "I've heard tell on it, but I didn't see it."

"Of course," continued Agrippa, confidentially, "a good deal may be found that we never hear of, but there's lots of little things picked up, and taken to the office. We've found lots of German silver and metal spoons; iron tobacco-boxes; nails, and pins; bones of various animals; bits of lead; boys' marbles, buttons, bits of silk, scrubbing-brushes, empty purses; penny-pieces, and bad half-crowns, very likely thrown down the gullies on purpose."

"We've found false teeth—whole sets at a time," said one of the men, "'specially in some of the West-end shores."

"Ah," continued Agrippa, "and corks; how about corks? I never see such a flood of corks, of all kinds and sizes, as sometimes pours out of this sewer into the Thames. Of course we find bits of soap, candle-ends, rags, seeds, dead rats and mice, and a lot of other rubbish. We enter these things in our books, now and then, but we're never asked to bring 'em afore the Board."

"Do any thieves, or wanderers, get into the sewers," I asked, "and try to deprive you of these treasures?"

"Very few, now-a-days," he replied. "Some

of 'em creep down the side entrances when the doors are unlocked, or get up some of the sewers on this side when the tide is low, under the idea that they're going to pick up no end of silver spoons. They soon find out their mistake; and then they take to stealing the iron traps off the drains."

By this time our bark had floated out of the broad archway of the sewer—an arch as wide as any bridge-arch on the Regent's Canal, and we were anchored in that pea-soup-looking open creek that runs for some distance along the side of the Equitable Gas Works. The end of this creek, where it enters the Thames, is closed with tidal gates, which are watched by a kind of sewer lock-keeper, who lives in a cottage immediately over the sewer. He cultivates flowers and vegetables at the side of the channel, and his little dwelling is a model of cleanliness and tasteful arrangement. His health is good, and he seems satisfied with his peculiar position; for instead of reading pamphlets on sewers and sewage-poison in the intervals of business, he cultivates game-cocks, and stuffs dead animals in a very creditable manner. It is within the power of any sewer-doctor to drive this steady workman mad:

> He dwells amongst the untrodden ways
> Beside the spring of Dove—
> A spring that very few can praise,
> And very few can love

Let us hope that the sewer-doctors and their theories will never reach him.

CHAPTER VI.

A BUNCH OF LEGENDS.

My friend Agrippa, with all his practical experience, anecdotes, and attentiveness, did not appear to me to be what is called "exhaustive" on the subject of old sewers. His stories wanted the fine full flavour that only age can bring, and his experience was entirely confined to the north side of the river. While the underground channels of the sunny south remained sealed up, or unexplored, I could not have felt that I had done my duty to my employers—the public. I should have been haunted by a suspicion that I had left many stories and features buried in the old borough of Southwark and its surrounding districts, which would be as seasoning pepper to far more statistics than I think proper to offer. Going to the Guildhall Museum, and seeing a piece of wood, which was found in the neighbourhood of St. George's Fields, in excavating the great Duffield Sewer, and which was labelled as being part of one of the piles of King Canute's trench,* made in May, 1016, my curiosity about the

* A trench is said to have been cut through the parish of Lambeth by King Canute, for the purpose of conveying his fleet to the west side of London Bridge to attack the city by water. The editor

southern sewers was naturally stimulated. While I gave those who hold the keys of Underground London to understand that I was not dissatisfied with the King's Scholars' Pond Sewer, I plainly told them that my appetite for information on sewer subjects was not yet half gratified.

A friendly official statement, that no length of covered main sewer on the south side was more than fifty years old, failed to damp my ardour. The reports of Mr. Gwilt and Mr. I'Anson, technically interesting as they undoubtedly were, only told me that most of the old sewers were anciently mill-streams and monastic water-courses; and that the whole southern valley district is under high-water mark—in some places as much as five or six feet. I went into various old sewers on the south side, that, in consequence of their peculiar geological position, can only be entered when the tide is low. In one I saw a barrow that had been washed down from some opening in the road at some higher point; and I heard of a bedstead that had been picked up in the flood not many months before. The theory was that it had been carried away by

of the last edition of "Aubrey" says that some traces of it were visible in his time. From the increase of new buildings, no vestiges of it are now to be seen, and the conjectures about its course are very various. After all, it is at least as probable that any remains of a trench which might have been visible half a century ago were of that which was made in the year 1173, for the purpose of altering the course of the river, when London Bridge was rebuilt. This trench is said to have begun in the east, about Rotherhithe, and to have ended about Battersea.

some heavy rain storm, from some yard or garden on the Surrey Hills, plunged into the sewers where they still form open ditches, and streamed down the tunnels towards the Thames. I was told of many dead children that had been picked up on this side of the river in the same manner, along with washing-tubs, mops, water-butts, and trunks of trees. In one old sewer under the Blackfriars Road, not remarkable for its purity, or its freedom from chemical refuse, I saw a cluster of mushrooms on the roof that were almost as large as ordinary soup-tureens.

These further experiences failed to satisfy me, and I asked for more. I wished to see one of the oldest working hands on the sewer establishment; a hoary mudlark who had been seasoned by nearly half a century's training, and who might fairly be regarded as a hermit of the sewers. My ideal of such a man was that of a sewer-flusher, who, by long familiarity with little else than the black underground streams of London, had come to regard the whole universe as one vast pool of sewage. No man who would have felt astonished at seeing the English Channel bricked over by contractors, and turned into a main sewer; or would have thought it singular to live over an outfall flood of sewage as large as Niagara, would have come up to my ideal. With some little difficulty, an old workman was found, who was not surprised to hear that I had been down various sewers, and took a deep interest in them. Nothing appeared to him more natural than that

people should like to go down sewers, and to talk about them for hours together.

Our interview began in a kind of underground cell, side-entrance, or bower, where a man is often put to watch the tide; but it was ended in a district engineer's office. The walls were covered with maps and plans; the tables had many specimen brick-bats upon them, all labelled and numbered; there were many pieces of pipe drain on the floor; many curious fossils on the mantel-shelf; and a row of champagne bottles filled with specimens of river sewage. There was method, business, and science in all this, but the degraded position of the champagne bottles struck me as approaching desecration.

"Them's not quite the things to squench your draft," said my companion, the old sewer workman, alluding to the bottles.

"Not exactly," I said; "the man who could treat old wine bottles like that must have been a savage teetotaller."

My companion, encouraged from time to time by my questions, began to unfold his fifty years' experiences. He was a stout, healthy-looking old man, with a face not unlike a large red potato. He was good-tempered, and proud of his special knowledge, but not presuming. In this he differed from one or two other workmen whom I had met, who seemed to wish me to understand that they, and they alone, knew all about the London sewerage system. His language was frequently rather misty, as the sample

just given will show; but a very little grammar will go a long way in the sewers, and working men have something else to think of beyond aspirating the letter H.

"They was like warrens," he said, alluding to the old south-side sewers, "you never see such shores. Some on 'em was open; some was shut; an' some was covered over with wooden platforms, so's to make the gardings all the larger. Some o' the shores was made o' wood, spesh'ly about Rode-ride; an' at S'uth'ark the people used to dip their pails in 'em for water. They made holes in 'em, so's to get at the water when the tide was up, an' I've seen 'em dippin' often nigh Buckley and Puckins's."

"Did you ever meet with any accident," I asked, "during the long time you have worked in the sewers?"

"Oh, yes," he said; "I've been knocked down a dozen times by the gas; spesh'ly nigh the dead ends o' shores, an' I've been burnt over an' over agen. When your light goes out you may know summat is wrong, but the less you stirs about the muck the better. I've carried a man as 'as bin knocked down, nigh a mile on my lines [loins] in the old days afore we could get to the man-hole. It's pretty stuff, too, the gas, if you can only lay on your back when it goes 'whish,' an' see it runnin' all a-fire along the crown o' the arch."

"I dare say," I said; "but sewers are quite bad enough to walk in, without these illuminations."

"Shores is all right," he returned, rather pettishly, "it's the people as uses 'em that don't know how to treat 'em. There's the naptcha-makers, an' those picklin' yards, where they soaks iron in some stuff to make it tough; they're nice places, they are, an' nice messes they makes the shores in at times. Then there's can'le an' soap-manyfact'rers, which sends out a licker that strong that it will even decay i'on an' brickwork. Then there's gas-tar-manyfact'rers, agen. We're 'bliged to go to all o' these people afore we goes down the shore, an' ask 'em to 'old 'ard. If we didn't do that, there'd be more on us killed than is."

"I suppose," I said, of course with a view of getting information, "the sewers you go up are often very small?"

"Some is two-foot shores," he replied, "an' they're tighteners; others is three-foot barrels; an' others is larger."

"Did you ever hear of any murder being committed in the sewers?" I asked, not being willing to give up the chance of a romantic story without a struggle.

"There was one open shore," he said, "that some o' the foremen used to call 'old Grinacre,' in the S'uth'ark districk, but that's bin covered over many years."

"What about that?" I asked, eagerly.

"Well," he said, "it used to bother us a good deal. One mornin', when the tide was all right, we goes down to work, an' picks up a leg!"

"A human leg?" I asked.

"Yes," he said, "all that, an' not a wooden one neither. Another night, when the tide was all right agen, we goes down, an' we finds another leg!"

"Another human leg?" I asked, in astonishment.

"Ev'ry inch on it," he returned; "an' that ain't all. Another time we goes into the same shore, an' we finds a arm, an' another time we goes down, an' we finds another arm."

It seemed very annoying to me that my companion was compelled to sneeze and cough at this point of his story for about the space of five minutes.

"What did you do?" I asked, excitedly.

"Oh," he said, "the foreman put 'em down in his book, an' they went afore the Board, an' it was a long time afore the Board could make anythin' of 'em. They sent a hinspector down, an' we found a few more legs—ah, an' even 'eads, to show 'im."

"What *was* the solution of the mystery?" I said, getting impatient.

"Well," he replied, "the cat came out o' the bag, at last. It was body-snatchers an' med'cal studen's. When the gen'elmen at the hospital 'ad done cutting up the bodies, they gets rid o' the limbs by pitchin' 'em into the open shore."

I was certainly disappointed at this tame conclusion to what I thought was going to prove a romantic story, and yet I persisted in questioning my witness,

in the hope of still meeting with some startling experiences.

"People *must* get down the sewers," I said, "by picking the locks of the side-entrances, even if they don't always come up at the low tide on this side of the river."

"Oh, they get down fast enough, sometimes," returned my companion, with a chuckle, "faster than they're always able to get up. I once 'ad a dog that got shut in a shore for a week, an' how d'ye think we got 'im out?"

"I can't imagine," I replied.

"Well," he continued, "two on us was agoin' along Roderide, one day, when I thought I 'card a pen-an'-inkin'* sound comin' up a gully. My mate didn't seem to see it, acos not having lost a dog, he wasn't thinkin' of dogs; but I made up my mind that it was a hanimal down the shores, an' what's more, that it was Flusher."

"Who's Flusher?" I asked.

"Why the dog," he said, "that's what we called his name. I goes to the nex' side entrance, an' almost afore I could get the trap open, up springs the very hanimal, an' falls senseless at my feet."

"Was he dead?" I inquired.

"No," he replied, triumphantly, "not he; he'd taken pretty tidy care of himself down the shores; an' he was only a little drunk with the fresh air."

"Talking about drunk," he continued, we've 'ad one or two rum goes o' that kind in the shores. I

* A curious phrase, which is held to mean the yelping of a dog.

remember once the side wall of a old main giv' way, an' the men found theirselves in a public-'ouse cellar. P'raps they 'adn't ought to've done nothink, but giv' the parties notis; but none on us, you know, is always perfec'. They took a little o' this, an' they took a little o' that, until I don't think they knew which was shore an' which was cellar. Lucky for 'em one o' the foremen came down afore the tide got up, an' 'ad the wall all made right, or they'd bin washed away, like a shot, tubs an' all."

"These were your regular men," I said; "but don't you remember any instances of strangers getting into trouble or danger down the sewers: like those men who went in the other day after the tallow from the Tooley Street fire?"

"Oh, yes," he returned, "many cases; but we never took much notice on 'em. Once I remember a case o' this kind, acos a fr'end o' mine was mixed up in it."

"Let us have it, then," I said.

"Well," he began, "a fr'end o' mine was smokin' his pipe one night at his garret-window, just as you might be, when he thought he 'eard a cough right agen his left ear. He starts up in a fright, an' looks roun', expectin' to see some one, but his missus 'ad gone out to get somethin' for supper, an' there wasn't nobody except 'imself in the room. Well, he goes back to the winder, an' looks out, to see if any neighbours was pokin' their fun at 'im, but he couldn't see no one right nor left. He sits down agen, an' begins smokin', when he hears a muffled

voice say, 'Where am I? The water's up to my neck; for Gawd's sake let me out!'

"When my fr'end 'eard this, he drops his pipe into the street, an' stan's for a minit struck all of a 'eap. He couldn't see no one, an' couldn't make out where the voice came from. While he was lookin' about, he 'card the same voice say, as nigh as he could recollect, 'Oh, dear me! Let me out, an' I'll never come down the shore agen.'

"When my fr'end 'card the word shore mentioned, somethin' struck 'im the voice came up the rain-pipe which went down the side o' the 'ouse into the main. The top o' this pipe was werry nigh my fr'en's winder, so he leans out, an' shouts down it, 'Who are you? What's your game?'

"'Oh, sir,' says the voice, 'I'm Bill Stevens, of Num'er two, Mill-pond Court, Roderide. I didn't go to do it, an' I'm bein' washed away in the shore.'

"It was a lucky job for Master Bill Stevens that my fr'end knew me, and knew where I lived at that time. He runs roun' to me at once, an' foun' me just goin' to turn into bed. I comes out with a key, an' goes down after my gen'elman, an' finds 'im arf dead wi' fright. There's no mistake about it; it ud a' bin over with 'im in another 'our, as the tide was comin' up fast. He'd stuck 'imself agen the side o' the shore, like a rat, 'olden on to the end o' the pipe, up which he shouted to my fr'end. We took 'im 'ome to his father, quite agen his grain; and the father says, ''Ang the shores; he's always down

the shores; we can't keep 'im out o' the shores; I wish there wasn't no shores.'

"'Well,' I says, 'you needn't go on about the shores. The best thing you can do, if the boy's 'ead runs that way, is to put 'im under a reg'lar flusher, an' let 'im larn the bus'ness.'"

"Did the father take your advice?" I asked.

"He did," replied my companion, regretfully, "but some 'ow it didn't answer. The boy wouldn't go into the shores when they wanted 'im, an' now, I think, he's a bricklayer, or somethin' o' that sort."

I soon found, after this, that I had completely exhausted my companion's stock of sewer anecdotes. I spoke to him about the great intercepting sewers now in progress, but the plan appeared to be a sealed book to him, and the discussion of it seemed to make his head ache. Thanking him, therefore, for the information he had given me, I turned my back, to some extent, upon the old works and the old workpeople, and proceeded to make an inspection of the new ones.

CHAPTER VII.

NEW CHANNELS.

THE British tax-payer is certainly an extraordinary creature. His paying power seems to be enormous, and his patience under financial milking is a lesson to noisy martyrs. He stands like a cow to give forth, and only exhibits the bull disposition when you tell him what has become of the milk. He has a fretful impatience of figures and statistical details, and can always be driven mad by a multiplication table. Some artful members of the small governing family have helped to nourish this disposition, by making his figures as dry and repulsive as possible. This is one way of choking an efficient audit. Other artful members of the same governing family have persuaded him that details are only fit food for the parochial mind, and that the parochial mind is a very low, vulgar form of popular intelligence. He has listened to the voice of the charmer until he has come to consider everything of importance except what is under his nose or beneath his feet. He watches "diplomatic complications" at German Peddlingburghs, takes note of what is doing for the people in the Maccaroni Islands, and is deeply in-

terested in any contest beyond the Dunghill Mountains. The consequence is that when a parish voting paper is left at his door, he has either no time or taste to look at it, or else throws it in the fire, and leaves the administration of millions sterling largely in the hands of potboys.

It is fortunate, perhaps, for the cause of good sewer government that sewers are a part of the parochial system that will not be neglected. The naming of streets, the watering of roads, and the feeding of paupers may be done by anybody, or nobody, or not done at all; but the sewers, if not properly treated, have a power of making themselves felt which they are not slow to use. At certain periods, and in certain conditions, they are allowed by nature to become so offensive, that poor John Cow is disturbed over his foreign affairs journal, and is unable to tell whether the Grand-Duke of Meddlingbeggar, or of Idlebeggar has the largest standing army. At these moments he is compelled to put down the telescope with which he has been sweeping the distant horizon, and to think a little about pipe-drainage, inclinations, the district sewer at the back of his premises, and the main sewer in the thoroughfare round the corner. He becomes aware that his neighbour next door may have more power to embitter his existence than all the grand-dukes and diplomatic complications in the world.

The great intercepting scheme of London main drainage, which has been many years before the metropolitan public on paper, and some years under

them in bricks and iron, must have originated from one neighbour grumbling at another. The London valley on both sides of the Thames, if it takes the trouble to look into its unfortunate geological position, has a splendid cause of quarrel with its neighbours, the upland districts. The sewerage system of the last fifty years has linked the whole metropolitan public together by vast underground chains, and has taught them that they are all suffering, onduring brothers. In this joint-stock company some few members have got the upper hand, and they lean very heavily on those below them. The central parts of London have to bear the gases generated by sewage from numerous surrounding neighbourhoods. A voice rises up in the City, with reason and indignation in its tones, and says, loudly, "Here's a pretty state of things! In the days of cesspools, sir, every household had to bear only so much annoyance as it created for itself; but we have changed all that. How many towns and villages now, sir, send their filth through the City, which, under the old cesspool system, had to keep it for their own farms and gardens? Sixty-nine separate populations, sir, numbering half a million of persons, send their refuse past our doors, as regularly as omnibuses run from Paddington to the Bank. Day and night, sir, we breathe an atmosphere tainted by these swollen underground streams, and have not even the poor satisfaction of sending some unbearable nuisance back. The country, sir, had need give us a few zephyrs, laden with odours of new hay

and wild thyme, as a set off against this bouquet of the thousand sewers."

Representations such as these, accompanied by the still small voice of parochial conscience, the enterprise and invention of engineers, and the ambition of legislative meddlers and social reformers, naturally produced a variety of sewerage schemes—before alluded to—which ended in the great intercepting project at present being carried out. The late Mr. Frank Foster, aided by Mr. Haywood, began this plan upon paper in 1849; Messrs. Bazalgette and Haywood modified, extended, and continued it, still upon paper, in 1854; the Metropolitan Board of Works, when it commenced its career, on the 1st of January, 1856, took it into consideration; Mr. Bazalgette remodelled the plan in 1856; a Government commission—before quoted—reported for and against Mr. Bazalgette's scheme, and for and against many other things, in 1857; Messrs. Bazalgette, Hawksley, and Bidder—also before quoted—again reported for and against the Government report; and, finally, Mr. Bazalgette, as engineer-in-chief to the sewer parliament, began to carry out his thrice-remodelled project of 1858.

Mr. Bazalgette's plan is to put something like a few sewer-girdles round London, though not exactly in the space of forty minutes. His best labours, and those of his able lieutenants, Messrs. Lovick, Grant, and Cooper, are doomed to be hidden from the public eye, and to dwell in perpetual darkness. Three vast tunnels on the north side of

the Thames, extending from west to east, and two vast tunnels on the south side, also extending from west to east, with several branches, will cut through the various Thames-seeking main sewers, at different levels, intercepting the daily millions of gallons of sewage, and carrying them away to the river at a point between Barking Creek and the Plumstead Marshes. These new main tunnels, some of which will help to drain the districts they pass through, will be at least seventy-one miles long; and will cost, with sewage-filtering reservoirs, pumping stations, engines, etc., at least three millions sterling. About five-and-twenty miles of these tunnels are now completed, and the contractors and their workmen are going on rapidly with the lengths left to be constructed. There are not wanting opponents to state that the whole structure is a costly mistake, and that a few years will open the eyes of the deluded ratepayers. Anything that opens the eyes of these apathetic taxpayers may be regarded as of some value; and as we are inclined to take the existing five-and-twenty miles of intercepting tunnel as a great accomplished fact, we may, perhaps, be pardoned for giving a few details about the work and its position.

On the north side of the river Thames, the high level sewer, or girdle, begins at Hampstead with a tunnel four feet in diameter, and extends, increasing here and there in size, until it reaches something like eleven feet square at the point where it joins the river Lea at Old Ford. Its course may be

roughly described as passing over the Highgate Road, across the fields into and down the Holloway Road, under the Great Northern Railway and New River cut to Stoke Newington, and then through Hackney and the Victoria Park to its aqueduct across the river Lea. It has just been completed, a round-about tunnel nine miles long, and swallowing up in its course that open part of the Hackney Brook which may have been a river in the time of the Romans, but which was decidedly a stinking ditch sewer in the days of Victoria. About half-a-million cubic yards of earth have been dug out to form the channel of this high level sewer; it has sucked up forty millions of bricks, two hundred thousand bushels of Portland cement, three hundred and fifty thousand bushels of lime, one hundred thousand cubic yards of concrete, seventeen tons of hoop-iron, and has employed fifteen hundred men from week to week. During the time of its construction we have had the wettest summer and the coldest winter upon modern record, and bricks have advanced in price at least fifty per cent.

With the exception of a large branch, or "storm overflow" tunnel, which has been constructed across Hyde Park and Kensington Gardens, to relieve the great Ranelagh sewer from floods, and give it another outlet into the Thames, these are the only new works on the north side that may be put down as no longer existing merely upon paper.* The Rane-

* This was written in June, 1861.

lagh sewer runs in the bed of the Westbourne, an ancient rivulet that flowed through Knightsbridge, and one of the numerous streams which came down from the Hampstead hills to the Thames. It's name is derived from its being the most westerly of those streams running through or by London. Rising at West-end Hampstead, and winding towards Bayswater, it passed through it, behind St. James's Church; here it crossed the Uxbridge Road, and entering Kensington Gardens, it passed through them and Hyde Park, where it ran along the centre of the Serpentine, into which it entered. By the addition of several ponds, it was widened in 1731. Leaving the Park, it crossed the Great Western Road at Albert Gate, thence it passed in an oblique line behind the east side of William Street and Lowndes Square, behind Lowndes Street and Chesham Street, and, bending to the right, passed under Grosvenor Bridge, where it divided itself, and flowed by two channels into the Thames. The eastern course of this lost river was stopped up when the Grosvenor Canal was formed, but the mouth may still be distinctly traced at the back of Westmoreland Street. The western mouth is now the entrance to the Ranelagh Sewer, to which the stream has for many years degenerated. By an under-current, formed in 1834, its course was diverted at Bayswater, to prevent drainage passing into the Serpentine; and when the "Five Fields" at Pimlico were intended to be built upon, a new sewer, for which Smeaton had previously made surveys, was con-

structed. The whole of its course is now covered in, although part of it was open in 1854.

The Westbourne, as a brook, was occasionally a source of annoyance to the inhabitants of Knightsbridge. After heavy rains it overflowed; and on September 1st, 1768, it caused great damage, almost undermining some of the neighbouring houses. In January, 1809, it overflowed again, and covered the neighbouring fields so deeply, that they bore the appearance of a lake, and passengers were for several days rowed from Chelsea to Westminster by Thames boatmen.

The great middle level sewer has certainly been begun at both ends, viz., at the Old Ford part of the river Lea and at Bayswater; but as it will have to pass through crowded thoroughfares, the contractors, Messrs. Brassey, are waiting until they are prepared to carry on the work with the utmost expedition. It will have three branches, called the Piccadilly, Dover Street, and Coppice Row branches. The main line begins in an egg-shaped tunnel, about four feet in height, and is to increase in size, here and there, until it ends in a circular tunnel, ten feet and a half in diameter. Its course will be from Paddington to Notting Hill, along Oxford Street, through Bloomsbury and Clerkenwell, along Old Street—one of the finest old Roman roads in London—across Shoreditch, through Bethnal Green, still keeping very much to the line of the old Roman road, and under the Regent's Canal, to Old Ford, where it will run for some little distance side by side

with the high level sewer. It has been estimated that about half a million cubic yards of earth will have to be dug out for this channel, and that it will suck up about fifty-five thousand cubic yards of concrete, and forty millions of bricks. The workmen employed in it will be at least a thousand.

You could ride for miles on horseback up either of these tunnels—the high level and the middle level sewers—going in at the lower end, where they run together for some distance under a raised clay and concrete embankment. In case of floods, they are provided with what are called "overflow chambers," a kind of gigantic letter-box, open at the top, built up at the sides, or in the centre of the sewers, where they join their channels together. These hollow chambers reach to within a few feet of the roof, and if the black underground stream rises above their edges, it will pour down them, as through a funnel, into two lower channels, thence into the river Lea, and by that stream into the Thames above Blackwall.

At Old Ford, where these two sewers run together, traditions and traces of the Romans may be found in any quantity. The workmen have picked up decayed skulls, broken pieces of huge pottery, pock-marked, singular-looking iron instruments, fossil shells, and some early English and Roman coins. If these relics were really planted to be dug up by the men, and sold to the contractors or the public, as a recent trial about like relics found at a like spot would seem to show, it is almost a pity that

any one should ever expose the deception. The relics are quite old and crumbled enough to make any ordinary contractor happy, or to attain an honoured position under the glass-cases of a museum. The coins are undoubted pieces of ancient money, and their presence in the stream is accounted for by the pleasing tradition that they were dropped by careless Roman passengers out of a Roman punt, at the time when Old Ford was a Roman ferry.

The northern outfall sewer, which is only just begun, is another part of the great intercepting scheme, existing only, at present, upon paper. It is intended as a channel to convey the combined stream of sewage from the river Lea to its reservoir and outfall in the Thames at Barking Creek. This outfall sewer will be about five miles long, and will consist for about one mile of two lines of tunnel enclosed in a raised embankment, and for the remaining distance of four miles of three lines of tunnel, each nine feet in diameter. It will cross over seven streams, including the river Lea; it will pass under the Eastern Counties Railway, and over the North Woolwich and Tilbury and Southend lines in aqueducts. It is estimated that about one million one hundred and twenty-four thousand cubic yards of peat and soft ground will have to be cut out and piled up to form the embankment; that six hundred and twenty-nine thousand cubic yards of concrete will be required for the same purpose; that the tunnels will suck up about twenty-seven thousand rods of reduced brickwork, one hundred and twenty mil-

lions of bricks, one million six hundred and fifty thousand bushels of cement, three millions eight hundred and thirty-four thousand bushels of lime, and four thousand tons of wrought and cast-iron for the bridges over the streams and railways. The natural drainage of the marshes will, of course, be carried under the embankment in culverts.

This great outfall sewer, which will empty itself into a covered reservoir at Barking Creek, capable of containing seven millions of cubic feet of sewage, will not only receive the combined streams poured into it by the high-level and low-level sewers just described, but another vast flood that will probably be pumped into it from another line of projected main intercepting tunnel, called the low-level sewer. This sewer depends so much upon the project of a Thames embankment, which has been for some time under the consideration of Parliament, that Mr. Bazalgette has wisely given up reporting about it until the great river terrace scheme shall be decided upon one way or the other. Its course, as laid down upon paper, is to hug the bank of the river from Chelsea, through Westminster, the Strand, Cannon Street, Eastcheap, Tower Hill, Stepney, and Limehouse, to the river Lea, where it will join the other intercepting sewers. It will take in five branches; from Brentford, Fulham, Victoria Street, Westminster, the Isle of Dogs, and Hackney Marsh in its course; and as its level will be about thirty-seven feet below the high-level and middle-level sewers, its stream will have to be

pumped by engine-power into the great outfall channel.

The great intercepting sewers on the south side of the river Thames are divided into a high-level tunnel and a low-level tunnel, with an outfall underground channel.

The high-level tunnel begins at Clapham Common, and winds its way through Stockwell and Camberwell to Peckham, where it is joined by a long fork or branch, called the Effra branch—an improved substitute for the open Effra ditch—which comes down from Dulwich. The two tunnels then continue from Peckham through New Cross, until they end in Deptford Creek, where they are provided with storm overflow chambers, very similar to those in the north-side sewers. The whole length of this high-level sewer is between nine and ten miles, and rather more than one half, at different points of its course, is just completed. It begins, like most of the others, as a circular tunnel about four feet in diameter, and increases here and there in size until it ends in a diameter at least ten feet and a half. When finished, it will cut off and divert the upland waters which now flood the low and tide-locked districts. It is estimated that this intercepting sewer will suck up eighty-two thousand cubic yards of brickwork, thirty millions of bricks, two hundred thousand bushels of cement, four hundred thousand bushels of lime, seventy-five thousand cubic yards of concrete, and will require more than half a million cubic yards of ground to be cut out,

and nearly the same quantity of earth and materials to be carted.

The low-level intercepting sewer is mapped out to run from Putney through Battersea, Brixton, Camberwell, the Old Kent Road, and across the market-gardens to Deptford. It will be provided with a couple of storm overflow branches, running into the Thames at Vauxhall and Deptford, and a north or Bermondsey branch, which will intercept many sewers running through that district. At present it can only be said to exist upon paper, although the contractors have begun the works at Deptford, where they found the undersoil to be a running sand, filled with an extraordinary volume of water. As this end of the low-level sewer will be at least twenty feet below the end of the high-level sewer, pumping power will be required, as on the north side, to raise the stream up into the great outfall tunnel.

The great southern outfall sewer, which may be regarded as a work second only in extent and importance to the northern outfall sewer, is more than half completed. It will pass from the Deptford pumping station through Greenwich and Woolwich under the Erith marshes to a covered reservoir capable of containing four millions of cubic feet of sewage, on the river bank at Crossness Point, beyond Plumstead.

The length of this main tunnel will be about seven and a half miles, and its diameter about eleven and a half feet. Its depth from the surface in

many parts is very great, especially about Woolwich, where the rough entrance-shafts are like the mouths of huge mines with ladders going down at different inclinations. Here the tunnel has been constructed for some distance, mole-like, under the ground, most probably without a large portion of the inhabitants being aware of its existence or progress. It is estimated that about half a million cubic yards of ground will have to be dug out for this channel, and that about the same quantity of earth and materials will have to be carted. It will suck up one hundred thousand cubic yards of brickwork, thirty-seven millions of bricks, and six hundred thousand bushels of cement; and when completed with the other works, it will receive and carry off the whole of the drainage of that portion of London which is on the south side of the Thames. These southern works, from their commencement to the present time, have given weekly employment to upwards of two thousand men.

The sewage reservoirs on the north side at Barking Creek, and on the south side at Plumstead Marshes, will be raised some twenty-one feet above the level of the outfall sewers, and the stream will be pumped into them. The final discharge of the fluid sewage at high water—the solid sewage being deposited in the reservoirs—will take place through covered channels buried under water, and communicating with the centre and bottom of the river Thames. The works have been calculated so as to admit of extensions as the metropolitan population

expands, and to carry off the sewage of three millions and a half of people, with the rainflow always oozing from the district they must necessarily occupy. The drainage area may be stated roughly as one hundred and fifty square miles; and the whole of the works, according to the original promise, are to be completed in 1863.

The two main principles at the bottom of this great plan, are to relieve certain low districts from the nuisances inflicted on them by certain high districts, and to save the Thames within the metropolitan boundary, even if the outskirts persist in defiling it, from being made the great cesspool of London. The London water companies, some by act of Parliament and others by choice, no longer make this London cesspool their feeding cistern, but have gone higher up the stream for their supply of water, while the sewer-lords are preparing to take the sewage lower down the channel. This seems to be a sensible divorce. The new system of drainage represents the struggle of art against nature; and if it prove successful, the almanacks will no longer be able to register the dates of high sewage at London Bridge. The fastidious moon—that emblem of purity—will no longer be disgusted by looking down upon a flood of something like pea-soup, and by knowing that its tidal influence is only washing backwards and forwards a stream which in decency ought to be covered over as a main-main sewer.

The sewerage scheme now being rapidly carried

out is so vast, that it has naturally driven many people almost mad who have grappled with it and opposed it. Some people cannot be brought to believe that any tunnels have been constructed anywhere, and they look upon the thick-ribbed shore-cuttings, the houses on wheels, and the excavators' spades and lanterns, scattered about in different parts of London, as mere surface decoys, set up to satisfy a few inquisitive ratepayers. Others regard the tunnels as only too real and substantial; volcanoes of filth; gorged veins of putridity; ready to explode at any moment in a whirlwind of foul gas, and poison all those whom they fail to smother. Others take the financial ground that the scheme will exhaust three millions sterling, without doing three-pennyworth of good; forgetting that the tunnels will always be worth their money as wine-cellars, bowling-alleys, skittle-grounds, flower-beds of romance, and fancy subways. If sewage should prove as obstinate as certain sewer-doctors predict, the tunnels may even serve as condemned cells for all our unruly, colony-rejected thieves and convicts.

CHAPTER VIII.

OLD CRUSTED LONDON.

THE London sewers have been fruitful in furnishing antiquarian and geological discoveries. In March, 1849, during excavations in Smithfield for a new sewer, and at a depth of three feet below the surface, immediately opposite to the entrance of the church of St. Bartholomew the Great, the workmen laid open a mass of unhewn stones, blackened as if by fire, and covered with ashes and human bones charred and partially consumed. "This," says Mr. Cunningham, "I believe to have been the spot generally used for the Smithfield burnings; the face of the sufferer being turned to the east and to the great gate of St. Bartholomew, the prior of which was generally present on such occasions. Many bones were carried away as relics."

When the new sewers were being constructed in the Strand, in 1802, eastward of St. Clement's Church, the workmen discovered an ancient stone bridge of one arch, about eleven feet in length. It was covered several feet in depth with rubbish and soil, and found to be of great strength. Mr. Malcolm, who records the discovery in his "Londinium Redivivum," says that a doubt arose whether it was

the "Bridge of the New Temple," passed by the Lords and others who attended Parliament at Westminster, after going out of the City to this place by water, which Edward the Third once called upon the Knights Templar to repair, or an arch turned over a gully or ditch, when the road, now the street termed the Strand, was a continued stream of filth.

Mr. C. Roach Smith says, "Some excavations made for sewers in Thames Street led to discoveries which confirm the truth of Fitz-Stephen's assertion, that London was formerly walled on the water-side; and although, in his time, the wall was no longer standing, at least in an entire state, there was probably enough left to trace its course by. This wall was first noticed at the foot of Lambeth Hill, forming an angle with Thames Street, and extending, with occasional breaks, to Queenhithe; and some walling of a similar character, probably a part of the above, has been noticed in Thames Street, opposite Queen Street. It was from eight to ten feet thick and about eight deep, reckoning the top at nine feet from the present level, and composed of ragstone and flint, with alternate layers of red and yellow, plain and curved tiles, cemented by mortar, as firm and hard as the tiles, from which it could not be separated. For the foundation strong oaken piles were used, upon which was laid a stratum of chalk and stones, and then a course of hewn sand-stones, from three to four feet long, by two and a half in width.'

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The old works have done this, and more, for archæology; and the new works have not been backward in helping geology. The following interesting paper, read by Charles Rickman, Esq., at the Geologists' Association, in the early part of the present year, shows what discoveries were made at Dulwich and Peckham, during the Excavations of the Effra branch of the Great Southern High-level Sewer:—

"The autumn of 1859," he says, "witnessed the commencement of the main drainage of the south of the Thames, when my attention was directed to the open cuttings at Peckham. In the spring of 1860, the more difficult operation of tunnelling under the Five Fields at Dulwich, afforded practical lessons both to the engineer and the geologist. It was in the latter capacity I first became acquainted with the sections thus exposed, and having devoted every available leisure hour on these works (from October, 1859, to July, 1860), I venture to lay before the Geologists' Association a brief narrative of my discoveries during the progress of the excavations, consisting of an open cutting running from Peckham Rye to New Cross, and the tunnel at Dulwich. Now, there can be no doubt that the strata passed through constitutes a portion of the Lower London Tertiaries, distinguished by Mr. Prestwich as the 'Woolwich and Reading Series,' and I have it as that gentleman's opinion, that the six feet of clay on the top of the main shaft at Dulwich may belong to the London clay; and I must confess, that when I

first visited the scene of operations at Peckham, I was so impressed with the analogy the different sands and clays bore to the familiar Woolwich series, both in their lithological and palæontological characteristics—as visible at Charlton and Blackheath—that I despaired of finding any additional fossil remains indicative of an extended fauna or flora; but a short acquaintance speedily led me to a very different conclusion. And here it is expedient I should explain that it was upon a huge spoil bank, near the Nunhead Cemetery, that I had so ample an opportunity of studying the organic remains, which was scarcely possible in the cuttings, on account of immense quantities of water, and the speed with which the sewer was constructed, and the opening filled up. Amongst this *debris* were masses of indurated clay, oftentimes of a highly crystalline character, making hydraulic cement, when burnt, equal to that manufactured from the nodules of septaria, so plentiful in the clays of the London basin and at Barton, presenting conchoidal fracture when broken contrary to the plane of stratification. It occurred about seventeen feet from the surface, having a uniform thickness of eight inches, and charged with myriads of casts of the well known fresh-water genus *Paludinæ;* it rested on an oyster-bed, made up of the remains of *Ostrea Tenera* (Sowerby), *Ostrea pulchra* (Sowerby), *Ostrea Bellovacina* (Lamark), *Ostrea elephantopus* (Sowerby), a *Bysso-arca*—considered by Mr. Edwards to resemble *Arca-Cailliaudi* (Bellardi), from the nummulitic beds of Nice, *Cyrena*

cuneiformis (Fér.), *Cyrena deperdita* (Sowerby), *Cyrena cordata* (Morris), *Melania inquinata* (Def.), *Melanopsis brevis* (Sowerby), *Modiola Mitchelli* (Morris), *Calyptræa trochiformis* (Zam.), and *Corbula;* all (with the exception of *Arca-Calliaudi*) being well known and characteristic fossils of the Woolwich and Reading series.

"I propose to distinguish the layer of indurated clay by the name of the *Paludina* band; in addition to the smaller species, the well known *Paludina lenta* (Brand), I also met with three specimens resembling the *Paludina aspera* (Michaud), from the fresh-water limestones of Rilley la Montague, which may probably be the species recorded by M. De la Condamine as *Paludina Desnoyersi* (of Deshayes); that species, however, appears to be more globose than the specimen from Peckham. In Sowerby's 'Mineral Conchology,' plate 50, fig. 1, is figured a specimen from East Peckham, to which the name of *Paludina elongata* is affixed; it would be interesting to ascertain if either of the specimens on the table is referable to this species. Associated with the *paludinæ* were casts of a *unio*, resembling, if not identical, with *Unio Solandri*, and another undescribed species of *unio* of large size. These blocks separated easily in the centre, exposing surface-planes of comminuted shells, with here and there fish-bones, teeth, and scales, the latter resembling those of *Lepidotus minor*. Some blocks yielded very beautiful specimens of leaves, my most perfect specimen being now in the British Museum. I have

failed, myself, to discover any insect remains of a definite character; but the researches of Mr. Evans clearly demonstrate their presence. A figure and description appear in the 'Geologist Magazine,' for January, 1861.

"Again, when fractured contrary to the plane of stratification, the surfaces thus exposed were often darkened with distinct semi-ovate patches, which I have ventured to conclude may be the *opercula* of the *paludinæ*. Lastly, with regard to this *Paludina band* at Peckham, I must not omit to mention the discovery of specimens of a spiral shell, generally casts or much eroded, occurring at rare intervals amongst the *paludinæ*, which, from its apparent resemblance, was at first referred to the genus *Voluta*, and was supposed to resemble the well known Bognor fossil, *Voluta denudata* (Sowerby).

"These specimens were submitted to the attention of many friends and conchologists, and, despite the seeming anomaly of a marine shell occurring in juxtaposition with an undoubted fluviatile genus requiring some slight amount of speculation to account for its presence, still it was gradually settling down as *Voluta denudata*, when an unexpected and fortuitous circumstance enabled me to clear up the mystery; for the spring of 1860 had now arrived, and with it the tunnelling operations were in full activity at Dulwich—the principal shaft had been sunk on an eminence in the Five Fields, at the spot where the trial-borings had been made. These latter gave the several thicknesses of clay, sand, and

gravel, approximating in accuracy to the working-section, with the exception that in the trial-section no mention is made of the shell-conglomerate. It became necessary to sink the shaft a depth of sixty-five feet, and then galleries were driven right and left, when, from the quantity of water, it was requisite to further sink what is technically called a sump, in order to drain the galleries. This sump collected the water, so that buckets descending whilst the skips filled with *debris* ascended, became filled with water, and in their turn reached the surface, and were emptied into troughs or shoots, the whole put in motion by a horse-gin; this was probably the simplest and most inexpensive machinery that could be used for such operations, of a purely temporary character. It was in the excavation of this sump that masses of the shell-conglomerate were first met with, imbedded in sandy clay, the natural section presenting a fractured condition, commented on even by the workmen, who referred it to the action of a whirlpool. It was at this time, one or two lengths of the galleries having been excavated, and prior to the brickwork being put in, that I was invited to descend the shaft. I did so, and was much struck with the singular appearance of the several strata, consisting of intercalated bands of dark black clay, greenish sand, and hard shelly rock, all running off into thin wedges, gradually thickening east and west. To the eastward, the circular gallery was ten feet in diameter, passing through the tenacious black clay, some tons of which were lying near

the mouth of the shaft on the occasion of my first visit. This clay was laminated, and in breaking up exposed very beautiful specimens of various kinds of leaves. These were not mere impressions, but the carbonized substance of the leaf still remained; and, as I have described elsewhere, 'it was possible in many cases to lift the leaf from the clay;' and I perfectly remember on some days, when the wind was rough, choice specimens which I had exposed to dry were blown away. Oftentimes the leaves formed a thin blackish carpet over many square feet of clay. I had no difficulty in collecting some hundreds of these leaves. The choicest specimens may now be seen in the British Museum and the Museum of Practical Geology. The most peculiar in form, occurring very rarely, was accurately figured in the 'Illustrated London News,' of March 24th, 1860, by Mr. S. J. Mackie, F.G.S.

"I will not assume to offer any opinion as to the botanical character of this flora. Leaves were plentiful which have a close analogy to the poplar, the willow, and the maple, now growing in the neighbourhood; but it would be difficult to find (except in the Tropical Department of the Crystal Palace, hard by) any congener of those magnificent lanceolate leaves, with serrated edges, which here and there darkened the surface of the clay.

"Lignite was very abundant, highly charged with iron pyrites. Very rarely I met with an obscure kind of seed-case, and what may either be the cat-

kin of the willow, maple, or hazel, and one or two specimens of petro-phyloides.

"In driving the galleries east and west, it was soon discovered that the shell-conglomerate became regularly bedded, and ultimately attained a maximum thickness of four feet. It was sometimes intercalated with bands of stiff blue clay, presenting in section a series of wedges, and even some of the hardest masses contained cavities filled with soft clay. It had a dip east and west of the central shaft, which appears to mark the axis of elevation. Two more shafts were sunk to the eastward and one to the westward, presenting a general resemblance to that just described. The galleries, when united, formed the entire length (three hundred and thirty yards) of the tunnel, which was constructed of a circular seven feet barrel-brick drain, set in concrete with Portland cement. The difficulty of the operations was much increased by the immense quantity of water occurring in the running sand.

"Simultaneously with the main shaft, the first one to the eastward was sunk; and here, early in the spring of 1860, I succeeded in laying open a large block of stiff blue-black clay, having exposed on its surfaces many leaves and three pairs of shells, which at once struck me as differing in form from any of the *cyrenæ* which I had previously met with.

"These were still covered with the epidermis; and it was also from amongst some broken specimens that Mr. Edwards was enabled to work out the hinge,

and determine that it was a new species of *cyrena*, which I have named and described as *Cyrena Dulwichiensis*. Its specific characters are, shell elongately oval, transverse, inequilateral, posteriorly slightly produced, and obscurely truncated; umbones prominent, tumid, curved; unule large, and of an oblong oval form. The anterior extremity presents on the surface numerous irregular and rather deep concentric furrows, which become shallower as they cross the middle, and almost obsolete over the posterior extremity. The shell is ornamented with irregular and longitudinal bands or rays of colour, usually eight or ten on each valve, but varying in number and breadth in different specimens. The shelly matter forming the coloured surface of these bands appears to have been particularly susceptible of disintegration, for most generally it was found to have been decomposed, leaving a perceptible furrow corresponding with the ray impressed on the surface. The hinge-lamina is much curved, and has three divergent cardinal teeth, of which the central one is slightly bifid, and two unequal compressed lamelliform lateral teeth, strongly serrated. Length, two inches and one-twelfth; height, one inch and five-twelfths.

"At this very time the main shaft was yielding many tons a day of the shell-conglomerate, and I soon discovered that my new-found *cyrena* of the clay-beds was also tolerably plentiful in the conglomerate more strongly exhibiting the colour-bands. Here it was associated with *C. cordata*, *C. deperdita*,

C. cuneiformis, Melania inquinata, Cerithium funatum (Mantell), a large species of *unio*, and a smaller one, probably *Unio Solandri*, together with large masses of lignite pierced by a large and undetermined species of *Teredina;* also crocodile scutes, fish-scales (resembling *Lepidotus minor*), and chelonian and mammalian bones. For several weeks I was unable to make out any univalve, with the exception of *Melania* and *Melanopsis*, and in the clay *Rissoa*, although I felt satisfied that I had observed some obscure fragments not referable to either of the foregoing; but one fortunate day a harder and more homogeneous mass yielded a perfect specimen, followed the next day by the discovery of another. This pair of shells I submitted to the notice of the eminent palæontologist, Mr. F. E. Edwards, who has described and figured this new genus under the name of *Pitharella Rickmani*. For that gentleman's remarks on this shell, and his reasons for considering it referable to one of the three families *Auriculidæ, Achatinidæ*, or *Limneidæ*, I beg to refer you to the 'Geologist' for June, No. 30, merely subjoining his description of the shell.

"'*Pitharella* (Generic Characters).—Shell subcylindrical; spire obtuse, more or less produced; aperture oval, oblong, rounded in front, narrowed behind; columella straight or very obliquely twisted, arched anteriorly; outer lip simple, inner lip thickened.

"'*Pitharella Rickmani* (Specific Characters).—Shell oval-oblong, smooth; spire sub-conical, short,

varying in height in different specimens; whorls, five or six depressed on the posterior margin, and obtusely angulated on the shoulders. The sutural edge is slightly thickened, forming a narrow, upright, ribbon-like band pressed against the preceding whorl, and feebly crenulated by the lines of growth; in well-preserved specimens, the margin immediately in front of the sutural band presents two or three obscure concentric furrows. The last whorl is somewhat attenuated towards the base; the aperture is entire, rounded in front, narrow behind, and very long, nearly equalling four-fifths of the entire length of the shell; the columella is obscurely and very obliquely twisted, and anteriorly is much curved. The outer lip is slightly arched, simple, and sharp on the edge; the inner lip is posteriorly thickened and narrow, anteriorly effuse, flattened and reflexed, forming an angular ridge on the columella and confluent with the outer lip. The dimensions of Mr. Edwards's largest specimen, if it were perfect, would be—axis, 2 inches and 2-12ths, nearly; diameter, 1 inch.'

"By comparison, it was soon ascertained that the casts occurring in the *paludina* band at Peckham were identical with the Dulwich *pitharella*. This induced me to revisit the Peckham excavations; and I then found tolerably perfect specimens, with the shelly matter still remaining, although in a very decomposed state. This identity is apparent by reference to the specimens on the table; and thus the mysterious obscurity in which the first speci-

mens were shrouded is satisfactorily cleared up, and the *voluta* enigma solved.

"Peckham.	Dulwich.
Fish bones, scales, and teeth.	Mammalian, Chelonian, Crocodilian, } Bones.
Leaves (rare).	Leaves.
Paludina lenta.	Fruit.
„ Desnoyersi.	Lignite.
Ostrea tenera.	Cyrena cuneiformis.
„ pulchra.	„ deperdita.
„ Bellovacina.	„ cordata.
„ elephantopus.	„ obovata.
„ edulina.	„ Dulwichiensis.
Arca Cailliaudi.	Paludina lenta.
Cyrena cuneiformis.	„ Desnoyersi.
„ deperdita.	Unio.
„ cordata.	„ Solandri.
Melania inquinata.	Melania inquinata.
Corbula.	Melanopsis.
Calyptræa trochiformis.	Ostrea pulchra.
Pitharella Rickmani.	„ Bellovacina.
Melanopsis brevis.	Arca Cailliaudi.
Unio.	Modiola Mitchelli.
Modiola Mitchelli.	Pitharella Rickmani.
Fusus.	Teredina.
Buccinum.	Rissoa.
Rissoa.	Neritina.
Insect remains, discovered by Mr. Evans.	

"The preceding lists indicate the number and species I have been able to make out at Dulwich and Peckham. A reference to them points to the fact that, in proceeding from the former to the latter place, we are as it were going seawards, as the shells are more purely marine at Peckham; or rather, that they there lie *in situ*, and in far greater num-

bers, whilst the estuarine shells are decidedly most plentiful at Dulwich, the conglomerate yielding shells of all stages of growth, and in countless myriads. Again, I am of opinion that the *paludina* band having comparatively the same mean level at Dulwich and Peckham, is due to the sudden irruption of some gigantic river charged with the spoils of a continent, as the eroded nature of the *paludinæ* and the *pitharellæ* at Peckham is a fact demonstrative of their having been transported a considerable distance. But then I am reminded by Mr. Prestwich, that the conditions of the London basin are ever variable and most perplexing; so that any attempt to define the configuration of land and water, and the limits of salt, lacustrine and fresh-water, during the epoch of the lower London tertiaries, is impossible with such a section as the one exhibited at Dulwich and Peckham.

"The presence in the clay of myriads of many species and varieties of leaves, in some instances mingled together in undistinguishable black masses, and in others small leaves exquisitely preserved—the venations as strongly marked and the serrated edges as sharp as when they flourished on the parent stem—all speak to us of vernal and autumnal seasons affecting forests growing on the banks of some unknown and mighty river, subject to periodical changes in the level of its waters, which swept the land as it were of its organic remains and its alluvial deposits. That myriads of the *cyrenæ* were entombed whilst yet alive, I argue from the

fact that in many cases the epidermis and hinge muscle still remained; and when first laid open, they shone in the sunlight with the irridiscent hues which of old they possessed in life. The small diamond-shaped and hard enamelled scales, together with palatal teeth, evidence the existence of fish closely allied to *Lepidotus minor;* nor are chelonian and crocodilian remains wanting, and what I have reason to suppose are mammalian bones. Some doubt has been expressed on this last head, and the specimens now exhibited are somewhat obscure; still I believe little doubt exists as to the true character of the bone I have deposited in the British Museum.

"*Lastly.* Lignite was very plentiful at Dulwich, all more or less bored by a large and new species of *teredina,* some of the tubes being nearly half an inch in diameter, many having the closed valves of the mollusc at the extremity of the calcareous tube; it is worthy of remark, that the *paludinæ* and the casts of *pitharella* associated with them at Dulwich are much stained with oxide of iron, which has effectually removed all traces of the shell.

"The Bysso-arca (*Arca Cailliaudi*) referred to as rather plentiful at Peckham, was very rare at Dulwich. I only saw one specimen sufficiently distinct to be identified.

"Subjoined are the thicknesses of the several deposits passed through in sinking the shafts at Dulwich:—

"MAIN SHAFT.

	Ft.	In.
Virgin soil	0	9
Loamy clay (probably London clay)	12	0
Mottled clays	8	0
Mottled sands	4	6
Clay, with cyrenæ	6	0
Paludina band	0	9
Sandy clay	3	0
Oyster-bed—sandy	1	8
Dark blue clay, with leaves	4	0
Green sand, with comminuted shells	7	0
Shell conglomerate fractured, maximum thickness in gallery	4	0
Sump. dark-blue clay, with leaves, lignite, shells, and bone	14	0
Total	65	8

"EAST SHAFT.

	Ft.	In.
Virgin soil	0	9
Loamy clay (probably London clay)	6	10
Red sand	5	6
Black clay, with leaves, lignite, etc.	2	2
Blue clay, ditto	1	10
Dark clay, ditto	1	6
Paludina band	0	8
Broken cyrenæ	1	0
Oyster-bed	1	0
Blue clay, with leaves	1	8
Dark sand	2	4
Blue clay, with leaves	1	6
Dark sand	9	3
Hard shelly rock . . bottom	—	—
	36	0

"WEST SHAFT.

	Ft.	In.
Virgin soil	0	9
Loamy clay (probably London clay)	9	3
Dark clay	2	0
Paludina band	0	6
Light sandy clay, with leaves	1	10
Blue clay, with oysters	3	0
Dark sand	0	8
Yellow sand	2	0
Blue clay, with leaves	2	6
Dark loamy land	0	8
Blue clay, with thin layers of land	9	0
Running sand, with water	4	0
Light-coloured loamy clay	2	6
Hard shelly rock . . . bottom	—	—
	38	8

"In the gallery east of the main shaft the shell-conglomerate attained a maximum thickness of four feet; but in the extreme east and west shafts, the shelly rock forms the base on which the brickwork of the sewer rests.

"The depth of the main shaft being so much in excess of the others denotes a considerable elevation at this point; but as the open cuttings now in progress are less than thirty feet deep, it is highly probable that for some time we must bid farewell to the highly interesting shell-conglomerate and its associated clays and sands."

CHAPTER IX.

UNDER ST. PAUL'S.

VERY serious objections were raised in 1831 on the proposal to construct a sewer near St. Paul's Cathedral, and the following correspondence—now historical—on the subject, was laid before the referees by F. C. Penrose, Esq., Surveyor to the Fabric of St. Paul's.

19th August, 1831.

SIR,—Until Mr. Acton's return I recommend you to suspend the works of the sewer on the south side of St. Paul's Cathedral, and unless you do so immediately, I shall feel it my duty to apply to the Lord Mayor to that effect.—I am, etc.

(Signed) C. R. COCKERELL.

Mr. Richard Kelsey.

32, Wilson Street, Finsbury Square,
19th August, 1831.

SIR,—Mr. Acton left town yesterday morning for a few days; but I will take care to transmit your letter as early as possible.

Had Mr. Acton remotely thought that the sta-

bility of St. Paul's Cathedral could be in the least affected by the sewer he is now constructing, good feeling would have instantly prevented his attempting it; but, upon reconsideration, I trust you will see that there is no ground for alarm upon the subject, and you may be satisfied that every requisite precaution will be taken by the commissioners to complete their works without injury to any one.

I know that Mr. Acton was not at all aware who was the surveyor to the Dean and Chapter; but it is certainly singular that, until so late as yesterday morning, you should have remained uninformed of a work which has been in progress for many weeks, especially as a Mr. Lingard, who described himself to be sub-surveyor to St. Paul's Cathedral, must have not only known it as matter of public notoriety in the neighbourhood, but was applied to by Mr. Acton, as the only ostensible person he knew in the business, that the bar on the north side of the Cathedral might be opened while the south side of the churchyard was necessarily closed.

After going through several official forms, Mr. Acton succeeded in obtaining permission from the Bishop of Llandaff and the Lord Mayor for the passage of carriages going westward, and it will be matter of regret to him that, after taking so much pains, and seeing so many persons, he should not have been made acquainted with the existence of a gentleman whose office and professional rank would, as a matter of course, entitle him to information on the subject.

I shall, in Mr. Acton's absence, feel happy to attend any appointment you may make; but you may rest quite assured that the work is in the hands of persons who will do everything which they feel necessary to execute their task in a satisfactory manner.—I am, etc.,

(Signed) RICHARD KELSEY,
Surveyor's Clerk to the Commissioners of Sewers.

C. R. Cockerell, Esq.

AT a Public Meeting of the Commissioners of Sewers of the City of London and Liberties thereof, held this day, 24th August, 1831, in Guildhall:

Resolved,—Upon consideration of the surveyor's report, that although this Commission entertain no apprehension that the safety of the Cathedral Church of St. Paul can be endangered by the sewer they are now constructing in St. Paul's Churchyard, yet, to meet the wishes of the Dean of St. Paul's, and to satisfy the public mind, they appoint and authorize Mr. Telford and Mr. Brunel, together with Mr. Acton, on their part, to meet and confer with Mr. Rennie and Mr. Smirke, together with Mr. Cockerell, on the part of the Dean and Chapter, and to report their opinion on the construction of the work, and the effect, if any, which it may have upon the foundation of the Cathedral, and that this Commission will be ready to receive and consider any suggestions

which the said gentleman may have to offer for the further security of the work. And for the necessary information of the gentleman to whose judgment the matter is referred, it appears to the commissioners to be absolutely requisite that the surveyor to the Dean and Chapter should, by examination, ascertain the precise depth and extent of the foundations of the Cathedral, and the nature of the soil or strata upon which they rest, and more especially as to that part of the fabric opposite to the sewer now in progress, and whether any other sewers or openings exist under any part of the Cathedral, and at what depth.

Resolved further, that the works in St. Paul's Churchyard be suspended until the said report be received.

(Signed) F. J. DONNE,
Principal Clerk.

Sewers' Office, Guildhall, 25th August, 1831.

SIR,—I am directed to acquaint you that Mr. Sibley has been appointed (instead of Mr. Telford, who was previously engaged) to confer respecting the construction of the public sewer on the south side of St. Paul's Churchyard; and as the work is now suspended, the Commissioners hope to be favoured with an early reply.—I am, etc.,

(Signed) F. J. DONNE,
Principal Clerk.

C. R. Cockerell, Esq.

Memorandum by MR. COCKERELL.

St. Paul's Churchyard, 1st September, 1831.

Met Mr. Walker on the part of Mr. Rennie; measured the depth of the well sunk at the east side of south transept, and found it 33 ft. 6 in.

The depth from top of well to level of street was 3 ft., leaving the depth of the well from the street pavement 30 ft. 6 in.

The workmen came to this depth at 4 o'clock P.M., on Wednesday, 31st August, when, finding the water come in fast upon them, they dug no lower; the water rose until 7 o'clock, 1st September, when, the sewer-pump beginning to ply, the water was cleared off in a great measure, but the bottom is now filled with water and sand, and the workmen state the sand (or bottom of the well) to have filled in about one-fourth.

A specimen of the sand and water is deposited in the vestry.

Well sunk on the south of transept in the street.

Measured and found this well 31 ft. below the street level.

The workmen arrived at this depth at 12 o'clock on 31st August, when, finding the water and sand come in upon them, they desisted.

Since then the sand and water have filled in 6 in. to a foot; the sand falling in from the sides, and undermining the sides (all round a 4-ft. well about 6 in.); it is observed that on the north side

of well towards cathedral, the sand has come in in greater quantity, making the side of the circle northward irregular and flat.

In both wells, underneath the potearth (the thickness of which varies from 3 ft. to 4 ft.), sand and gravel in layers have been found to the depths above mentioned.

Called on Mr. Allsop (late Pellat and Green), and found his well 23 ft. below level of street, and the water has hitherto been 6 ft. to 8 ft. high; making the top of water 13 ft. to 17 ft. from the level of the street pavement.

Saville Row, 1st September, 1831.

SIR,—I beg to inform you that, in conformity with the suggestion of the Commissioners of Sewers, I have caused holes to be dug in three places, in order to ascertain the facts of the depth of the foundations of the Cathedral, and the nature of the strata upon which they are placed. These holes are on the west and east sides of the south transept, close to the sides of the fabric, and in the street at the south front of the south transept, the two latter (on the east and south) are as deep as the workmen have been able to dig with security, the sand and water coming in upon them, and a greater depth requiring pumping and steyning. These experiments leave no doubt of the accuracy of the historical account of the fabric.

These openings having been completed this morning, I take the earliest opportunity of communicating the result; and I have directed the deputy surveyor, Mr. Lingard, who is in attendance in the Cathedral, to afford you every means of examining them with reference to the subject in hand. —I remain, etc.,

(Signed) C. R. COCKERELL,
Surveyor to the Fabric of St. Paul's.

J. Acton, Esq.

Red Lion Place, Giltspur Street,
1st September, 1831.

SIR,—Agreeably with your orders, I have measured the distance between the pavements near, and the sand in the shafts on the east and south sides of the south transept of St. Paul's Cathedral, at different times—at one o'clock, at three, and at four; and find the distance in each shaft to be uniformly the same; that is, 33 ft. 3 in. in the east shaft, and 30 ft. 6 in. in the south. There is rather less water in the shafts than when you were there, owing to the sewers' pumps having been in constant work.—I am, etc.,

(Signed) HENRY MUNN.

C. R. Cockerell, Esq.

Memorandum by Mr. Cockerell, 2nd Sept., 1831.

	ft.	in.
Mr. Munn found the opening east of south transept	32	4
So that since yesterday the sand has risen	0	11
Total	33	3

Extract of Letter.

Wintershall, 2nd September, 1831.

Your letter is so far satisfactory as to show that the sand is a quicksand, and therefore dangerous to the church. The great error has been, to attempt making the sewer without due notice to you; and the question now is, whether the continuation of the sewer is dangerous to the edifice. Reasoning abstractedly, if the sides of the excavation could be kept from running in, and no displacement of the sand takes place, no danger can be apprehended; but if the sand is found to run, and cannot be kept back, the excavation is dangerous. The next question is, what is to be done? My answer is, that I shall be in town on Monday morning at ten, and decide accordingly, and visit St. Paul's immediately.

(Signed) George Rennie.

C. R. Cockerell, Esq.,
etc., etc., etc.

6th September, 1831.

SIR,—I am requested by Mr. Smirke and Mr. Rennie, appointed in conjunction with myself by the Dean and Chapter, to advise respecting the new sewer in St. Paul's Churchyard, to say that, feeling the importance of the operation to the Commissioners of Sewers, to the public, and to the fabric, of as early a communication of their opinion on the subject as possible, they think no time should be lost, and finding a meeting of all the persons appointed is extremely difficult to arrange, and, from a meeting of five of the six persons to-day, that Mr. Brunel coincides in a great measure with them respecting the operation; they beg leave to recommend to the Commissioners of Sewers to adopt a line of sewage further removed from the fabric, their opinion being that great risk is incurred to St. Paul's Cathedral by the present line.

That in the hope the Commissioners will find the means of adopting another line, they forbear to make any observations on the present, or any other mode of execution of the work in the present line, their conviction being that the present line cannot be carried into effect with due regard to the security of the Cathedral.

(Signed) C. R. COCKERELL.

Mr. Acton,
Surveyor to the Commissioners of Sewers

Stratford Place, 6th September.

My DEAR COCKERELL,—I did not receive your note till yesterday evening, and having made several engagements for this morning, I could not attend the discussion referred to in your note, nor, indeed, did you say where it was to take place.

When you communicate the observations you have made upon the water and sand in the wells, I think there will be no question about the "prudence" of altering the line of the sewer.

Yours, etc.,

(Signed) ROBT. SMIRKE.

C. R. Cockerell, Esq.

Memorandum by Mr. COCKERELL.

We are informed by the "Parentalia," p. 260, which is the only authentic account I am acquainted with, that the fabric of St. Paul's is founded on a bed of potearth, six feet thick to the north, and four feet thick on the south; that under this bed, down to the level of low-water mark, is a sand so loose as to run through the fingers, to the thickness of about 40 ft., to the original London blue clay; the bed of potearth is found from 12 to about 20 ft. below the present surface, by various experiments, both within the crypt and in the street; the present sewer is 35 feet below the surface of the street, at the south gate, consequently 15 ft. below the bed of potearth; the apprehension

is the removal of a vein of running sand, connected with the bed described, may endanger the stability of the bed of potearth superincumbent, with the cathedral placed upon it. Not only the present operation affords abundant grounds for such an apprehension, but if in so large a drain, 6 × 7 feet, at least 20 feet circumference, by 400 or 500 feet long, at any time the smallest accident in the drain might admit the running sand with the stream of water, and thus carrying the sand through the sewer, gradually undermine the Cathedral itself.

That the account of "Parentalia" is correct, is proved by the fact that the opening in the bed of sand in Paul's Chain has given vent to the water in the sand, so as to oblige the erection of a steam-engine to keep the sewer already building dry, and secure the workmen; and all the wells round the churchyard north and south have been dried as far as the Newgate Market wells. The excavation to the south of the cathedral is inundated with a running sand and water, so as to put the workmen and works in great danger, only warded by planking and caulking with the utmost attention by 3 and 4 feet at a time; such planking is left behind the walls of the sewers, but it is impossible to retain the sand; consequently it may be feared that much more than the contents of the sewer, 6 × 7, is removed, and already damage may have been occasioned; the continuing of it seems obviously fraught with the utmost peril to the Cathedral.

Copy of Report.

We, the undersigned, having by the direction of the Dean and Chapter of St. Paul's Cathedral examined and considered the situation in which the Commissioners of Sewers have begun to construct a sewer on the south side of the Cathedral, and considering that the footings of the walls rest chiefly upon a thin bed of potearth, beneath which is a very deep stratum of sand and gravel containing a considerable quantity of water, and that the walls of the south transept have sunk, and are fractured, apparently, by reason of some partial weakness in this part of the foundation; are of opinion that the security of the fabric will be endangered if the sewer is constructed in the churchyard.

We are likewise of opinion, that however carefully the work may be constructed, it will be scarcely possible to prevent some degree of motion from taking place in the said stratum of sand and gravel, either during the construction of the sewer, or at a future period, in consequence of it. And we therefore earnestly recommend that the Commissioners should be requested to abandon this line for their sewage, and remove it to such a distance as will prevent all risk of injury to the perfect security of the Cathedral.

(Signed) Robert Smirke.
George Rennie.
C. R. Cockerell.

Saville Row,
10th September, 1831.

Copy of Letter obtained from City Commissioners of Sewers.

Sewers' Office, Guildhall, 21 September, 1831.

SIR,—The Commissioners of Sewers of the City of London and liberties thereof have had under their consideration the report of the surveyors appointed in relation to the public sewer intended to be constructed through part of St. Paul's Churchyard, and I am directed to acquaint you, the Commissioners have ordered the shaft near the south transept of the Cathedral to be filled up forthwith, and to be made secure under the direction of their surveyor; and I am further to acquaint you, they have determined that a portion of the course of the sewer shall be diverted from the intended line; and that, instead of continuing it westward on the south side of St. Paul's Churchyard, it shall be constructed from Watling Street, through part of the Old Change and Little Carter Lane, to communicate to the sewer recently built in Paul's Chain.—I am, etc.

(Signed) F. J. DONNE,
Principal Clerk.

P.S.—I have been directed to make known the determination of the Commissioners to the Lord Bishop of Llandaff.

C. R. Cockerell, Esq.,
etc. etc. etc.

CHAPTER X.

THE GIANT SEWER.

When the late Mr. Wordsworth stood upon old Westminster Bridge on the morning of September 3rd, 1803, and composed that famous sonnet on the sleeping city, he could hardly have been aware of the dead and living organisms which even then formed part of the flowing river. As nothing offended the nostrils of the poet, he felt at liberty to write that graceful line—

"The river glideth at his own sweet will,"

in ignorance, no doubt, of all the impurities which the broad stream held in solution. It was left for a later and more sanitary age to destroy part of the poet's dream by introducing the microscope in no friendly spirit. Mr. R. Etheridge, F.G.S. and F.R.S.E., in a report upon Thames mud and water, made to the Government referees on the Metropolitan Main Drainage in 1857, has spared no pains to expose the inner pollution of our unfortunate river. His report is very elaborate and very learned, and while some readers may think that a plain translation ought to have been given, others will doubtless feel that half the horror lies in the language.

Dating from the Philosophical Institution, Bristol, Mr. Etheridge says:—

"Gentlemen, I beg to transmit you herewith the results of the microscopical examination of the Thames mud and Thames water, which I undertook at your request.

"The samples are marked and numbered as in the following list.

"No. 1 to 18 inclusive, constituting the samples of mud and deposit; and letters (A.) and (B.), the two samples of water; one of which I designate thick water (A.), collected from a pool, the other clear (B.)—comparatively clear water from the tide-way at low water, at Hungerford Pier. The mud, consisting of the very thin surface deposit, was collected from the last or newest deposit of the Thames at about low water, early in the morning, before the great steamboat traffic on the river had commenced, which has been found to prevent the copious subsidence of solid matter which takes place during the night.

"I have adopted your suggestion of a classification, which, although not following any special or generally recognized system, shows most clearly the natural habitat of the living organisms, and their relation to the present subject.

"The term *stercorine* includes those forms whose natural habitat is peculiarly in sewage or other water holding matter in a state of decomposition.

"In respect to the numerical expression, indicating the proportion of the organic and inorganic

matters submitted to my notice, it will be readily seen that to have given critically exact terms would have involved a much larger scope, both of time and appliances, than was available; but my judgment, after reviewing the whole question, and having regard to all the specimens, leads me to consider that twelve to fifteen per cent. of the whole consisted of organic matter, living and in a state of decomposition, including forms called into existence under the peculiarly favourable influences and circumstances for their development, and the remainder consists of inorganic matter, for the most *part alluvial*, but containing at least twenty per cent. of abraded road material, granite, porphyry, and other crystalline rocks, and about thirty per cent. of what was evidently crushed flint, gravel, and earthy deposit of the basin of the Thames.

SAMPLE 1.

(Fifty yards below Southwark Bridge.)

I.—ORGANIC MATTER.—LIVING ORGANISMS:

Animals:

a. Fluviatile forms
- Class—Infusoria
  - Euplotes charon.
  - Uvella virescens.
  - Kolpoda cucullus.
- Class—Diatomaceæ
  - Navicula amphisbœna.
  - Gallionella.

b. Marine forms
- Class—Foraminifera — Rotalia,
- Class—Zoophyta — Gorgonia (spiculæ of).

c. Stercorine forms
- Class—Annelida
  - Lurco.
  - Vibrio anguillula glutinis.
  - Red worm.
- Class—Infusoria
  - Oxytricha gibba.
  - Paramecium aurelia.

Plantæ:
Filaments of fresh-water algæ.

II.—Organic Matter in a State of Decomposition:

a. Animal matter, or tissues
- Muscular fibre.
- Ochreous substance.

b. Vegetable matter, or tissues
- Spiral vessels (probably rhubarb) abundant.
- Scalariform and dotted ducts.
- Cellular tissue (water plants).
- " " sedge.
- " " rhubarb (probably).
- Siliceous epidermal coverings (wheat).
- " " " (barley).
- Pigment cells of wheat (caryopsis).
- Cellular tissue, potato.
- Hairs of plants (labiatæ).
- " " (compositæ).

c. Fæcal matter
- Black-looking (carbonaceous matter) substance in large quantities. This carbonaceous substance seems to be a natural carbon; masses often striated and of indeterminate character, and filthy in the extreme, constitute a great portion of this deposit. I doubt not it is human fæces disintegrated, and contains the remains of digested and chemically altered food; muscular fibre can be detected in many of the masses.

III.—Inorganic Matter:

a. Extremely fine particles of argillaceous matter (alluvion), finely divided, and having no definite form, being the chief muddy deposit of the river, argillaceous.

b. *Water-worn, and angular siliceous* or quartz grains (ground flint), in great quantity.

c. Felspar (small portions), mica, etc., appears to be the disintegration of granite and other crystalline rocks, and general washings of the streets of the city.

This sample was most offensive and filthy, evidently sewage deposit or accumulation, the great mass of organic matter being decomposing vegetable and animal organisms, having its origin in human food, and other city sources, and the living forms, such as would be found in sewage and other similar conditions only.

SAMPLE 2.

(Fifty yards below Southwark Bridge).

I.—ORGANIC MATTER.—LIVING ORGANISMS:

			Animals:
a. Fluviatile forms	Class—Diatomaceæ	Navicula amphisbœna.	
		Gallionella.	
	Class—Infusoria	Kolpoda cucullus.	
b. Marine forms	Class—Foraminifera	Rotalia.	
	Class—Zoophyta	Gorgonia (spiculæ of).	
c. Stercorine forms	Class—Annelida	Lurco Red worm	Abundant.
	Class—Infusoria	Oxytricha gibba	Abundant.
			Plantæ:
			Several filaments of conferva.

II.—ORGANIC MATTER IN A STATE OF DECOMPOSITION:

a. Animal matter - { Muscular fibre (masses).
Brown ochreous substance.

b. Vegetable matter -
- Cellular tissue of plants (several kinds).
- " " lettuce and stomata.
- " " onion.
- " " potato.
- Starch grains of (probably) potato.
- Spiral vessels (of rhubarb probably), large quantity, in masses.
- Hairs of plants (compositæ and labiatæ).
- Epidermal coverings (siliceous), wheat straw.
- Pigment cells (wheat caryopsis).
- Fig seeds (2).
- Palæ of grass.
- Small fragments of deal, well developed.

c. Fæcal matter - - Black-looking and ochreous-coloured masses, blotched and striated, mucous; appears evidently to be altered human food. This constitutes a large proportion of the mass under examination.

III.—Inorganic Matter:

a. Fine particles of argillaceous matter (alluvion), having no definite form; the chief muddy accumulations from the banks of the river.

b. Water-worn, angular, and large siliceous or quartz grains, of all forms, in large quantity.

c. Little felspar and mica, as in Deposit 1, all evidently from the disintegration of the city and the washings into the sewers.

SAMPLE 3.

(Fifty yards below Southwark Bridge.)

I.—Organic Matter—Living Organisms:

a. Fluvintile forms -	Class—Infusoria	-	Animals: Paramecium aurelia. Kolpoda cucullus.
	Class—Diatomaceæ	-	Gallionella.
b. Marine forms -	Class—Foraminifera		Rotalia:
c. Stercorine forms -	Class—Annelida	-	Lurco. Vibrio anguillula glutinis. Red worm.
	Class—Infusoria	-	Oxytricha gibba.

II.—Organic Matter in a State of Decomposition:

- *a.* Animal matter
  - Ochreous substance.
  - Muscular fibre and animal matter in abundance.
- *b.* Vegetable matter
  - Spiral vessels abundant and in large masses (rhubarb probably).
  - Cubical parenchyma (water plant).
  - Prismatic.
  - Pigment cells (caryopsis of wheat).
  - Siliceous cuticle of wheat straw.
  - Cellular tissue of potato.
- *c.* Fœcal matter
  - Fœcal matter most abundant.

III.—Inorganic Matter:

The inorganic bodies in this deposit exactly resemble those before described, both as regards quantity and general condition.

Free sulphuretted hydrogen escaped in considerable quantities from this sample; indeed, the mass exhibited a large quantity of decomposing vegetable and animal matter, in masses, with partial and almost complete decomposition.

SAMPLE 4.

(Fifty yards below Southwark Bridge.)

I.—Organic Matter—Living Organisms:

- *c.* Stercorine forms
  - Class—Annelida — Animals:
    - Lurco.
    - Vibrio anguillula glutinis.
  - Class—Infusoria
    - Oxytrica gibba.
    - Paramecium aurelia.

No fluviatile or marine forms detected in this sample.

II.—Organic Matter in a State of Decomposition:

- *a.* Animal matter
  - Ochreous and carbonized matter, striated and blotched; decomposing.
- *b.* Vegetable matter
  - Spiral vessels, Cellular tissue of various kinds — abundant.
  - Hairs of plants (compositæ).
  - Hairs of wheat from caryopsis.
  - Siliceous epidermis of wheat straw.
  - Starch grains (coloured by iodine).

c. Fæcal matter - - { The same black and brown carbonaceous-looking matter, with patches of muscular fibre (altered), some of indeterminate character. The whole of this, I have no doubt, is fæcal, and from the slaughter-houses, etc., etc., in large quantities.

III.—Inorganic Matter:

This so closely resembles those before described, that description is unnecessary.

This deposit is filthy in the extreme; chiefly of sewage origin, and yielded sulphuretted hydrogen freely.

SAMPLE 5.

(Fifty yards below Southwark Bridge.)

This sample or mass is more impure, and contains more decomposing organic tissues than the previous, No. 4.

I.—Organic Matter—Living Organisms:

c. Stercorine forms - { Class—Annelida - { Animals: Lurco. Red worm; very numerous. Ova of ditto. | Class—Infusoria - Oxytricha gibba.

No fluviatile or marine forms detected in this matter.

II.—Organic Matter in a State of Decomposition:

a. Animal matter - { Much animal matter; masses of carbonized matter of fleshy consistency, striated; evidently muscular fibre.

b. Vegetable matter { Cellular tissue, large masses } abundant. Spiral vessels, large masses } Dotted ducts. Epidermal siliceous cuticle of wheat straw and caryopsis. Starch grains of potato. Hairs of plants. Pigment cells of some plant.

III.—Inorganic Matter:

Precisely of the same mineral and lithological characters as those previously examined; the quartz grains seem more firmly divided and rounded than that of Nos. 2 and 3.

SAMPLE 6.

(Similar in general condition to No. 5.)

I.—Organic Matter—Living Organisms:

c. Stercorine forms

Animals:

- Class—Annelida: Lurco, abundant. Vibrio anguillula glutinis.
- Class—Infusoria: Kolpoda cucullus, Paramecium aurelia, Oxytricha gibba — few.

No fluviatile or marine organisms detected.

II.—Organic Matter in a State of Decomposition:

Plantæ:

b. Vegetable matter

- Cellular tissue, potato.
- Spiral vessels (sparingly).
- Loose cellular tissue (abundant).
- Hairs of plants.
- Siliceous covering to wheat straw.
- Parenchymatous tissue (like cabbage).

a. Animal matter

- Hairs of mammalia, ox or cow, „ „ man — In several little masses.
- The same ochreous substance.
- Brown or black carbonized matter, etc.

II.—Inorganic Matter:

a. A much larger proportion of grains of silica in this than in either of the other deposits, and less alluvial or clayey matter.

b. Felspar and mica also more abundant.

No sulphuretted hydrogen obtained from this sample.

The samples taken from this locality, when carefully examined, seem to much resemble those from Southwark Bridge; but, on the whole, the amount of dead organic matter is even greater than those previously examined, and the inorganic debris considerably more so.

SAMPLE 7.

(Hungerford Pier.)

I.—ORGANIC MATTER:

			Animals:
a. Fluviatile forms	Class—Diatomaceæ		Synedra ulna. Gyrosigma hippocampa. Nitzschia elongata. Navicula amphisbœna.
	Class—Infusoria		Kolpoda cucullus.

b. No marine organisms detected.

c. Stercorine forms	Class—Annelida		Red worm. Lurco. Vibrio anguillula glutinis.
	Class—Infusoria		Paramecium aurelia. Oxytricha gibba.
			Plantæ:
			Filaments of fresh-water algæ.

II.—ORGANIC MATTER IN A STATE OF DECOMPOSITION:

a. Animal matter	Much decomposing animal matter, ochreous-looking, and partly carbonized. Hairs of mammalia.
b. Vegetable tissues	Spiral vessels (abundant). Cellular tissue (cabbage). " " (potato). Siliceous covering (epidermal), wheat straw. Dotted ducts. Hairs of plants.
c. Fœcal matter	The same black carbonized-looking masses, with pigment tissue and mucous masses.

III.—ORGANIC MATTER:

a. Very finely divided quartz grains, forming fine dust-like deposit, but all siliceous. Some of the worn fragments large, and rounded.

b. Felspar, little or none.

SAMPLE 8.

(Hungerford Pier.)

This deposit much resembles No. 7.

I.—Organic Matter.—Living Organisms,

			Animals:
a. Stercorine forms	Class—Annelida		Red worm.
			Vibrio anguillula glutinis.
	Class—Infusoria		Kolpoda.
			Euplotes charon.
			Paramecium chrysalis.
	Class—Diatomaceæ		Synedra ulna.
			Navicula (several species).

II.—Organic Matter in a state of Decomposition:

b. Vegetable matter	Cellular tissue (loose), abundant.	
	Spiral vessels (probably rhubarb).	
	Hairs of plants.	
	Siliceous epidermal tissue (gramineæ).	
	Dotted vessels.	
a. Animal matter, etc., fæcal	Much matter (animal) in a state of putrefaction; appears to be muscular fibre and animal food acted upon by digestion. The ochreous substance (brown) mentioned in all the previous deposits.	

III.—Inorganic Matter:

a. The mineral and lithological character of this closely resembles that of No. 7, the amount of disintegrated silica being very large.

b. Felspar and mica, sparingly.

SAMPLE 9.

(Hungerford Pier).

I.—Organic Matter.—Living Organisms:

Animals:

a. Stercorine forms:
- Class—Annelida:
  - Vibrio anguillula glutinis.
  - Lurco.
  - Red worm.
- Class—Infusoria:
  - Kolpoda cucullus.
  - Paramecium chrysalis.

II.—Organic Matter in a State of Decomposition:

Plantæ:

b. Vegetable matter, etc.:
- Cellular tissue (loose and abundant).
- Spiral vessels (rhubarb probably).
- Siliceous coverings to the gramineæ.
- Hairs of plants.

a. Animal matter, etc., fæcal:
- The decomposing animal matter is much the same here as in No. 8, chiefly fæcal, and very offensive.

III.—Inorganic Matter:

a. Nearly all the sedimentary mass of this sample consisted entirely of quartz grains, much rounded and worn, the particles of argillaceous deposit or matter being less in proportion than those examined from Southwark Bridge.

d. Felspar and schorly-like-looking crystals broken up; also much carbonaceous matter, pieces of coal, and ashes.

This sample yielded sulphuretted hydrogen copiously.

SAMPLE 10.

(Hungerford Pier.)

This sample so closely resembles Nos. 8 and 9 in every respect, that it needs no enumeration as regards the organic or inorganic contents.

It yielded *sulphuretted hydrogen*, was *most offensive*, and contained much fæcal matter.

The siliceous accumulations, gritty particles, and debris of the crystalline rocks extremely large, as noticed in No. 9. The same coaly matter.

SAMPLES 11 AND 12.

(Hungerford Pier.)

I cannot add or detect for addition anything in these two samples different from those mentioned as coming from the same locality; the organic and inorganic conditions are precisely the same, being equally offensive, which undoubtedly arises from sewage deposit.

I cannot help remarking upon the excess of ground siliceous particles and debris of granitic and crystalline rocks in these samples from Hungerford Pier, especially the finely-pulverized silica of all colours, red, brown, white, etc.; they are also larger in size than those examined from Southwark Bridge; much of this looks like the finely-powdered or disintegrated gravel of the Reading district, mixed with granite debris.

SAMPLE 13.

(Temple Pier.)

As far as the organic and fæcal matter can be diagnosed in the samples brought from this locality, it much resembles those previously examined; there is a greater excess in quantity of the *respective organisms*, both living and that *undergoing decomposition*, especially the latter, which may be justly termed filthy in the extreme.

II.—ORGANIC MATTER.—LIVING ORGANISMS:

Animals:

a. Stercorine forms
- Class—Annelida * — Lurco. Red worm. Vibrio anguillula glutinis.
- Class—Infusoria — Swarms with monads which live amongst the masses of annelida (which are much decomposed). Paramecium aurelia.

* These are here much decomposed.

b. Marine forms	Class—Foraminifera	Rotalia.
c. Vegetable forms	Class—Plantæ	Filaments of fresh-water algæ.

II.—Organic Matter in a State of Decomposition

		Plantæ:
a. Vegetable tissues		Spiral vessels (probably rhubarb). Dotted ducts. Cellular tissue (loose). Ditto (potato). Siliceous coverings of the gramineæ. Hairs of plants.
b, c. Animal matter, fæcal		Much decomposing and slimy matter, of the same nature as that previously described, the ochreous and carbonized-looking masses being abundant. This is undoubtedly animal and fæcal matter.

III.—Inorganic Matter:

The siliceous and crystalline particles here are much worn and broken down, although a considerable portion are fresh and angular, or bear a more crystalline character than that constituting the mass of the deposit at Southwark Bridge.

There is also much coaly matter in this mass, true coal: its origin might be from the coal-yards.

SAMPLE 14.

(Temple Pier.)

I.—Organic Matter.—Living Organisms:

			Animals:
a. Stercorine forms	Class—Annelida		Lurco. Red worm. Vibrio anguillula glutinis.
	Class—Infusoria		Paramecium. Monads (swarming).
b. Marine forms	Foraminifera		Rotalia.
c. Vegetable forms	Class—Algæ		Filaments of conferva.

II.—Organic Matter in a State of Decompostion:

Plantæ:

a. Vegetable tissue - { Spiral vessels (abundant). Cellular tissue. Ditto - - with stomata (fresh). Hairs of plants. Potato cells and starch grains.

b. Animal tissue - - { Muscular fibre and fleshy-looking masses in considerable quantity.

c. Fæcal matter - - { A large quantity of decomposing ochreous brown and black-looking masses, striated, and partly cellular.

III.—Inorganic Matter:

a. The usual condition of rounded and angular siliceous grains, finely pulverized.

b. Much argillaceous matter, and fine sediment.

c. Felspar, mica, sparingly.

This sample was extremely filthy, and yielded sulphuretted hydrogen freely; the quantity of vegetable and animal matter under decomposition abundant. *Fætid and filthy.*

SAMPLE 15.

(Temple Pier.)

This sample was precisely the same as No. 14, as regards the vegetable and animal matter living and under decomposition; the quartz ore particles were more numerous, and rolled; the chief feature in this, as in the other, being the masses of tissues under decomposition.

There was also much coaly substance, evidently true coal, finely sifted and washed.

SAMPLE 16.

(Temple Pier.)

I.—Organic Matter.—Living Organisms:

Animals:

a. Stercorine forms -	Class—Annelida - -	Lurco.	
		Vibrio anguillula glutinis.	
	Class—Infusoria - -	Kolpoda cucullus.	
		Paramecium chrysalis.	
		Monads (swarming).	
b. Marine forms - -	Class—Foraminifera	Rotalia.	
c. Vegetable forms -	Class—Algæ - - -	Empty filaments of algæ.	

II.—Organic Matter in a State of Decomposition:

Plantæ:

a. Vegetable tissue -	Spiral vessels, Cellular tissue	in masses and quantity.
	Hairs of plants.	
	Siliceous epidermis (wheat straw).	
b. Animal tissue - -	Masses of yellow matter, striated, which appears to be muscular fibre.	
c. Fæcal matter - -	Ochreous, dark brown, carbonaceous-looking masses, as before described and noticed.	

III.—Inorganic Matter:

The same as in other samples, the difference being little or none.

SAMPLE 17.

(Temple Pier.)

Nothing can be said respecting this sample more than has been done in Nos. 13, 14, 15, and 16; in every respect it is the same, both as regards the organic and inorganic proportions.

SAMPLE 18.

The animal and vegetable matter in this sample very abundant, the whole rapidly decomposing.

I.—Organic Matter:

			Animals:
a. Stercorine forms	Class—Annelida		Lurco. Red worm. Vibrio anguillula glutinis.
	Class—Infusoria		Paramecium aurelia. Kolpoda cucullus. Oxytricha gibba.
	Class—Diatomaceæ		Naviculæ. Synedra.
			Plantæ:
a. Vegetable forms	Class—Algæ		Filaments of conferva.

II.—Organic Matter in a State of Decomposition:

		Plantæ:	
a. Vegetable tissue		Spiral vessels Cellular tissue	in large masses.
		Hairs of plants.	
		Starch grains (potato).	
		Epidermal covering (gramineæ).	

The same ochreous and fæcal matter in profusion.

III.—Inorganic Matter:

The condition of the general mass of the sedimentary matter in this sample is the same as in the other deposits from the same locality.

WATER (A.)

(Thick Water.) (Hungerford Pier.)

Nothing can exceed the filthy condition of this sample of water, which contained, with the exception of the annelid forms (in quantity), almost all the conditions registered in the sedimentary samples.

The contents I arrange and list in the same manner as the samples of mud.

I.—Organic Matter.—Living Organisms:

		Animals:
a. Stercorine forms	Class—Annelida	Lurco (few).
	Class—Infusoria	Kolpoda cucullus. Paramecium aurelia. Oxytricha gibba.
b. Fluviatile forms		Ova of mollusca (lymnæa). Portions of carapaces of several entomostraca.
b. Fluviatile forms	Class—Diatomaceæ	Navicula amphisbœna. Synedra ulna. Gomphonema, 2 sp.

II.—Organic Matter in a State of Decomposition:

	Plantæ:
Vegetable matter	Spiral vessels (of rhubarb probably). Hairs of plants (several kinds). Colpenchymatous tissue and stomata. Cellular tissue (floating masses). Wheat straw tissues (siliceous). Fungus-like-looking masses, flock-like, in suspension. (Torulæ ?)

The fæcal and brown striated fibrous substance observed in all and every sample before mentioned was equally abundant here, and

rapidly settled into regular layers, according to their respective densities. The quartzose grains and argillaceous sediment were most copious, and formed one quarter of the whole; another quarter was entirely organic matter; the remainder, water, was turbid, and never became clear.

WATER (B.)

(Clear Water.) (Hungerford Pier.)

The condition of this water differs remarkably from the former (A.) in every respect, and appears to be the general running water of the Thames. After careful filtering, the washed or retained matter was abundant in organic beings and organic matter, all of which partook more or less of those forms expected to be found in water such as would constitute the great mass of the Thames at this locality.

Most of the contents of this water was disseminated through the whole, there being little or no sediment, what little did occur being non-organic, and consisted of finely-divided quartz grains and argillaceous matter; but even in this sample the same ochreous body (striated) occurred, which is undoubtedly striated muscular fibre.

I.—ORGANIC MATTER.—LIVING ORGANISMS: Animals:

Fluviatile forms	Class—Infusoria	Vorticella nebulifera (abundant). Vorticella campanula. Euplotes charon. Monas crepusculum. Bodo.
Fluviatile forms	Class—Diatomaceæ	Gallionella distans. Gomphonema.
	Class—Zoophyta	Spiculæ of fresh water sponge. Human hair (little).
	Class—Crustacea	Ova of Daphnæ.

II.—Organic Matter in a State of Decomposition:

Plantæ:
Filaments of torulæ (fungi).
Cellular tissue of plants.
Hairs of plants.
Fragments of wheat husks.
Animal matter - Brown striated muscular fibre.

III.—Inorganic Matter:

Little sediment of quartz and argillaceous grains.

Dr. Hofmann, F.R.S., and Mr. H. M. Witt, follow up this attack in a report upon the "Influence of the Sewage on the Composition of Thames' Water." —"In order," they say, "to gain some insight into the manner in which the discharge of the London sewage into the river affects the composition of the Thames' water, a number of specimens, taken by the referees of the Metropolitan Main Drainage Scheme at different points of its course, were submitted to an analysis by us, in which the total amount of solid matter, the quantity of mineral, and the quantity of organic matter, were carefully determined. The results of the experiments are embodied in the following Table, which gives likewise the date on which the samples were collected, and the locality whence they were derived. It deserves to be mentioned, that the samples were delivered to us by the referees simply labelled with the letters (likewise recorded in the Table), so that the places whence they were taken were not known to us at the time the experiments were performed.

ANALYSES of the WATER OF THE THAMES, taken at Different Points of its Course.

Label of Sample	A. 1, 2, 3, & 4.	B. 5, 6, 7, & 8.	C. 9, 10, 11, & 12.	D. 13, 14, 15, & 16.	E. 17, 18, 19, & 20.	F. 21, 22, 23, & 24.	H. 29, 30, 31, & 32.	K. 43, 44, 45, & 46.
Point whence taken	Half a mile below Richmond Bridge.	Above Teddington Lock and Weir.	Half a mile below Kew Bridge.	Half a mile below Hammersmith Bridge.	Half a mile below Hammersmith Bridge.	Half a mile below Kew Bridge.	Wandle River, Wandsworth, below the mill and sewer.	Opposite Wandsworth Lock.
Date	14 March, 5.5 p.m.	14 March, 6.35 p.m.	16 March, 2.0 p.m.	16 March, 3.5 p.m.	16 March, 4.35 p.m.	16 March, 5.20 p.m.	18 March, 12.0 noon.	18 March, 6.0 p.m.
Depth of Water	High water, 5 feet.	High water, 7 feet.	Low water, 5 feet.	Low water, 7 feet.	High water, 13 feet.	High water, 10 feet.	Low ebb.	Low water, 14 feet.
SUSPENDED MATTER: (*Grains per Gallon.*)								
Mineral			3·32	2·50	2·20			
Organic			0·71	0·53	0·69			
TOTAL	0·57	0·36	4·03	3·03	2·89	0·04	0·77	0·81
DISSOLVED MATTER: (*Grains per Gallon.*)								
Mineral	19·03	16·49	19·75	18·40	17·92	17·38	22·18	21·44
Organic	0·99	1·43	1·13	0·87	1·30	0·85	1·40	1·17
TOTAL	20·02	17·92	20·88	19·27	19·22	18·23	23·58	22·61
TOTAL Amount of Solid Matter Suspended and Dissolved: (*Grains per Gallon.*)								
Mineral			23·07	20·90	20·12			
Organic			1·84	1·39	1·99			
TOTAL	20·59	18·28	24·91	22·35	22·11	18·87	24·35	23·42

ANALYSES of the WATER of the THAMES, taken at Different Points of its Course.

Label of Sample	L. 47, 48, 49, & 50.	M. 51, 52, 53, & 54.	O. 55, 56, 57, & 58.	P. 59, 60, 61, & 62.	Q. 63, 64, 65, & 66.	S. 71, 72, 73, & 74.	T. 79, 80, 81, & 82.	V. 75, 76, 77, & 78.	W. 83, 84, 85, & 86.
Point whence taken	Opposite Wandsworth Lock.	Westminster Bridge, under the fifth arch.	London Bridge, centre arch.	Westminster Bridge.	London Bridge, centre arch.	Opposite Victoria Docks, Blackwall.	Opposite Victoria Docks, Blackwall.	Rainham Creek.	Rainham Creek.
Date	18 March, 6.0 p.m.	19 March, 6.30 a.m.	19 March, 1.15 p.m.	20 March, 2.0 p.m.	20 March, 6.45 a.m.	20 March, 1.20 p.m.	21 March, 8.20 a.m.	21 March, 10.50 a.m.	21 March, 6.0 p.m.
Depth of Water	High water, 19 feet.	High water, 21 feet.	Just before flood, 12 feet.	Just at flood, 8 feet.	High water, 24 feet.	Low water, 14 feet.	High water, 30 feet.	High water, 36 feet.	Low water, 14 feet.
SUSPENDED MATTER: (*Grains per Gallon.*)									
Mineral	5·48	3·23	4·40	1·83	2·53	3·44	7·42	44·37	37·81
Organic	1·48	0·92	1·03	0·55	0·96	0·79	1·40	9·24	5·97
TOTAL	6·96	4·15	5·43	2·38	3·49	4·23	8·82	53·61	43·78
DISSOLVED MATTER: (*Grains per Gallon.*)									
Mineral	18·19	20·26	19·27	17·81	20·37	22·21	44·20	127·65	126·04
Organic	0·88	1·02	1·16	0·94	1·32	1·24	0·88	3·33	1·48
TOTAL	19·07	21·28	20·43	18·75	21·69	23·45	45·08	130·98	127·52
TOTAL Amount of Solid Matter Suspended and Dissolved: (*Grains per Gallon.*)									
Mineral	23·67	23·49	23·67	19·64	22·89	25·65	51·62	172·02	163·85
Organic	2·36	1·94	2·19	1·49	2·28	2·03	2·28	12·57	7·45
TOTAL	26·03	25·43	25·86	21·13	25·17	27·68	53·90	184·59	171·30

"In glancing at the results contained in the Table," say the chemists, "it is at once obvious that the amount of suspended matter contained in the different specimens of water cannot possibly be considered as representing the degree of sewage-pollution of the river.

"The mere *amount of mud* affords no evidence of the extent of contamination with sewage; all rivers necessarily carry along large quantities of mud, which, if the water be agitated in consequence of the current, or by the traffic of steamboats, is prevented from settling and renders the water turbid. When the bottom of the Thames is stirred up at Kew or Richmond, the water becomes as thick and opaque as at London Bridge; in fact, our analyses show that at Rainham Creek, which the London sewage probably never reaches, the river at the time the sample was taken was more muddy than at any other point in its course.

"It is rather the *chemical nature of the mud,* and especially the per centage of *organic matter* and of *nitrogen,* from which the contamination with sewage within certain limits can be inferred. We have not determined the amount of nitrogen in the mud, but even the percentage of organic matter is sufficiently characteristic of its nature.

TABLE.—PER CENTAGE of ORGANIC MATTER in the Mud at Different Points in the River's Course.

(Calculated from the relative Proportion of Mineral and Organic Matter given in the preceding Table.)

At Kew Bridge. C.	At Hammersmith Bridge. D.	Wandsworth Lock. M.	Westminster Bridge (High Water.) L.	Westminster Bridge (Flood.) P.	London Bridge (High Water.) Q.	London Bridge (Flood.) O.	Victoria Dock (Low Water.) S.	Victoria Dock (High Water.) T.	Rainham Creek (High Water.) V.	Rainham Creek (Low Water.) W.
17·61	16.01	21·32	22·14	23·09	27·69	19·00	18·60	15·88	17·22	13·63

"This Table speaks for itself; the maximum being at London Bridge, and the proportion of organic matter in the mud steadily declining in either direction."

After these cruel and searching analyses, who can turn again with any feeling of pride and pleasure to that fine poetical description of Sir John Denman?—

"My eye, descending from the hill surveys,
Where Thames among the wanton valleys strays:
Thames, the most loved of all the Ocean's sons,
By his old sire, to his embraces runs,
Hasting to pay his tribute to the sea,
Like mortal life to meet eternity.
Though with those streams he no resemblance hold,
Whose foam is amber, and their gravel gold;

His genuine and less guilty wealth t' explore
Search not his bottom, but survey his shore.
* * * *
Nor are his blessings to his banks confined,
But free and common as the sea or wind.
* * * *
Oh could I flow like him, and make his stream
My great example as it is my theme!
Though deep, yet clear, though gentle, yet not dull,
Strong without rage, without o'erflowing, full." . . . .

Full, indeed, murmur Messrs. Etheridge, Hofmann, Witt, and a host of others;—too full to be pleasant to a population of three millions.

CHAPTER XI.

RUNNING BROOKS.

FEW of us who have fed in youth upon stories of adventure and discovery have been without an early ambition to distinguish ourselves as travellers. Not knowing that Bruce was looked upon as a dangerous romancer, and forgetting that Mungo Park perished in the desert, no man can tell how, we have most of us laid down the well-thumbed records of their wanderings with a youthful yearning that nothing but a good tramp could satisfy. In this half-gipsy, sea-going, harness-breaking frame of mind, we have regarded every muddy fish-pond as an undiscovered, mysterious lake, and every slow-creeping rivulet as an untraced Nile. Then, as each summer's Saturday came round—the blessed Saturdays on which the school-doors had no power to hem us in, and even the stern schoolmaster looked and spoke like some other man—we have sallied forth with a bundle of cold meat and bread, a top-string, leaded at the end, to use as a plummet; a faithful, blinking, idiotic-looking dog, whose red tongue lolled out, to the horror of passing old gentlemen; and a sixpenny compass bought at a toy-shop, which shook like a mountain of calves'-foot jelly. Turning our

backs upon the spreading claws of bricks and mortar, we have sought for wonders, and have met them more than half way. We have magnified the road-side rat-hole into a grotto of Antiparos; we have seen in the sunburnt haymaker a friendly but untutored savage; and having devoured our bread and meat before we got a mile upon our journey, we have cheerfully cast ourselves on the world with a belief in the bounty of Nature. Glancing occasionally at our tremulous compass, out of respect to our book-knowledge, we have yet guided our steps by the rules of eye, of fancy, and of touch. We have struggled through prickly hedges, staggered over ploughed fields, trespassed upon private property in defiance of surly bulls, printed notices, and all the terrors of horse-whips and law, and by the time that the sun was high in the heavens, we have begun to feel the pangs of thirst. From that point of our wanderings everything became coloured by the hope of finding water. If we turned to the right or left, it was with the desire to discover a brook; and if we went to the top of a hillock, and took a sweeping view of the country, it was with a desire to sight some barn or village where we could beg a cup of drink. In these straits, our dog was an intelligent and useful companion, and when our mouths began to feel as if they were full of paste, and we had tried the plan of sucking a pebble to find it a mockery and a snare, this faithful animal led us, like blind men, down into a valley, where a clear stream, running over a gravelly bed, and half filled with

islands of green water-cresses, was waiting for our refreshment. Without stopping for a benediction, we were instantly down on our faces, with our mouths sucking in the water, our hands scooping it up, and even our caps employed as water-pouches. We were not checked by any fear of chilling our young blood, or by any theory that enough is as good as a feast. We drank our three times three in that reclining position, and seemed loth to leave the fountain that had comforted us in our need. By proposing to trace the friendly stream to its final outlet in some river, we appeared to repay the favour we had received, while we turned our wandering tastes into something like a useful direction.

In our gipsy-like journeys of this kind—and they were doubtless many and frequent—we often reversed this process, and starting on the banks of a river, a streamlet, or even a canal, we found a delight in following it upwards to its source. Then the top-string plummet came into repeated, but not very clearly defined usage; and the dog was sent into the water so often after pieces of wood, that he came out at last like a sleek seal, and almost shook himself to pieces to get rid of the moisture. If he stood for a moment on any spot, he made it look like a puddly street on a wet day, and we avoided him as an overcharged living sponge, ready to give off a shower at any instant.

In one of those boyish water-course journeys, undertaken in direct imitation of Mr. Bruce, the Abyssinian traveller, I remember dabbling, wading,

and raking with some companions in a small, shallow streamlet, like a ditch, some few miles out of London, when we were addressed by a pleasant middle-aged gentleman in clerical costume.

"Young gentlemen," he said, with an air of melancholy, "I think you would treat that rivulet with a little more respect, if some one told you its history."

"We were only hunting a rat, sir," we replied, somewhat abashed, and thinking that, perhaps, he might be the owner of the property.

"You are now standing," he continued, speaking at us rather than to us, "in the famous Tyburn Brook, which once flowed from Hampstead, by many channels, into the Thames, and which was one of the earliest principal fountains that supplied your City ancestors with water."

"Indeed, sir," we said, respectfully but incredulously, "was it older than the New River?"

We asked this question because we knew something about the New River, and had heard much about its extreme age.

"It supplied conduits," he returned, "centuries before the New River was thought of, and deserves better treatment than it now gets as the 'King's Scholars' Pond' main sewer."

"Did it give the water for nothing?" asked one of my companions, who had a natural aptitude for figures.

"It supplied it for nothing," he replied, "as all streams and wells do, up to a certain point. Nature

is bountiful, but uncertain; art is exacting, but reliable. Some people left money to establish conduit-pipes, and maintain them as a charity; others erected these structures, and paid themselves by a recognized toll."

This unexpected lesson in the fields carried us back, in imagination, to our hateful school, and sounded very much like the Rev. Mr. Blair's instructions in English composition. It was accepted in all politeness, and forgotten immediately by my arithmetical companion, but it made a lasting impression upon me. I dreamed of strange figures pouring out water day and night into the tankards of water-carriers; some like venerable giants with inverted pitchers under their arms; others like accommodating lions worked as pumps, with their tails for handles, and their mouths for spouts. I was not easy till I had searched the history of our London water supply in my school over-time; and I found the study, like all studies which we select for ourselves, far more agreeable than otherwise.

CHAPTER XII.

OLD FOUNTAINS.

"ANCIENTLY, until the Conqueror's time," says old Stow, the best of all London historians, "and for two hundred years after, the Citie of London was watered (beside the famous river of the Thames on the south part) with the river of Wels, as it was then called, on the west; with water called Walbrooke, running through the midst of the Citie into the river Thames, serving the heart thereof; and with a fourth water or Boorne, which ran within the Citie through Langbourne Ward, watering that part in the east. In the west was also another great water, called Oldborne."

Langbourne Ward has taken its name from a long bourne of sweet water, which formerly broke out in the fens about Fenchurch Street, ran down that street along Lombard Street to the west end of St. Mary Woolnoth's Church, where, turning south, and breaking into small shares, rills, or streams, it left the name of Shareborne Lane implanted in the City.

"There were three principal fountains* or wels,"

* There are now eighty-five charitable drinking fountains erected in London, and used daily by a quarter of a million of people.

continues Stow, "in the other suburbs: to wit, Holywell, Clement's Well, and Clerke's Well. Neare unto this last fountaine were divers others wells: to wit, Skinner's Well, Fag's Well, Tode Well, Loder's Well, and Radwell." The Clerk's Well, as we have before stated, has been dry for many years—an unsightly ruin of bricks and mud; and now even the iron tablet which marked its site has been taken away by the authorities of Clerkenwell. It stood in Ray Street, near the Sessions House, and near where the underground railway is now passing. If the waters of this well had been in existence, there is every prospect that this new undertaking would have drawn them off, as a clause in the act of Parliament provides that the railway company shall compensate all parishes for the destruction of any wells which they may pass through.

In West Smithfield, in the old days, there was a pool called Horsepool, and another near to the parish church of St. Giles's, Cripplegate, besides many smaller springs and wells throughout the City.

When the streams and wells became partially dried up or exhausted, in the course of time, and the number of citizens, as our historian phrases it, "mightily increased," they were forced to seek for waters at some little distance.

"The first cisterne of lead," continues Stow, "castellated with stone in the city of London, was called the great conduit, in Westcheap, which was begun to be builded in the yeare 1235." The water was brought from Paddington, and, according to

Mr. Matthews, in his "Hydraulia," it was the first known attempt to supply London with water by means of leaden pipes. Though the execution of the Westcheap conduit scheme was commenced in 1235, the following year another transaction took place, which displays the great attention bestowed upon the supply of water at that period. It was recorded that some merchants of Amiens, Nele, and Corby, being solicitous to obtain the privilege of landing and housing wood, etc., actually purchased it from the Lord Mayor and citizens for the consideration of a yearly payment of fifty marks, and the donation of one hundred pounds towards the expense of the operations then going on for conveying water from "Tyborne" to the City. This important undertaking originated in a grant from Gilbert de Sandford to the corporation, enabling them, with the assistance of the citizens, to lay down a leaden pipe from six fountains or wells at Tybourne. It is doubtful how far the pipe extended towards the City. Stow says, "In 1432 Tybourne water was laid into the Standard, Cheapside, at the expense of Sir John Wells, mayor; and likewise in 1438, by another lord mayor, Sir William Eastfield, from Tybourne to Fleet Street and Aldermanbury."

The Tybourne Brook, which had a large share in furnishing these town water supplies, is now, as my teacher in the fields told me, the King's Scholars' Pond sewer, which we have lately been surveying.

This sewer, according to Mr. Cunningham, takes its name from a pond which once stood on the bor-

ders of the river a little below Chelsea. Before it became a main sewer it was a brook or bourne, called Tybourne, also Ay-brook, and Eye-brook, and famous for giving a title to the village of Tyburn. The brook had its source at West End, Hampstead, and, after receiving many tributary streamlets, it ran duesouth across Oxford Street, near Stratford Place, by Lower Brook Street and Hay Hill, through Lansdowne Gardens, down Half Moon Street, and through the hollow of Piccadilly into the Green Park. There it expanded into a large pond, from whence it ran past the present Buckingham Palace in three distinct branches into the Thames. Rosamond's Pond, in St. James's Park, filled up in 1770, was partly supplied by its waters. When Tyburn Church was rebuilt, it was dedicated to the Virgin, by the name of St. Mary-le-bourne, because it stood on the borders of the stream; and hence we get the present corrupted names of Marylebone, Marrowbone, and Marie-la-bonne.

Though the conduits were supplied freely by these country brooks, the public had not free access to all the conduits. One citizen, a wax-chandler in Fleet Street, who had secretly pierced a conduit within the ground in 1479, and so conveyed the water into his cellar, was tried and convicted, and condemned to ride through the city with a conduit upon his head.

The rules and regulations concerning the conduits, with the prices of water, are preserved for us in some old Ludgate parochial documents, quoted

by Malcolm: "January, 1585, it was agreed in vestry that there shall be three water-bearers and no more, and they all to be men, and not any of their wives nor servants; and they shall deliver seven tankards of water, winter and summer (so that the tankards be six gallons apiece), for twopence [our water now costs about a farthing for the same quantity]; and that they shall carry no water to any person dwelling out of the parish; and also that if any of them set out any tub or tubs (as heretofore they have done) to the annoyance of the street, every such person shall be disabled and debarred to carry any water from the conduit. . . . Also, it is ordered and agreed by a vestry holden the 12th day of January, in the thirtieth year of our Sovereign Lady Queen Elizabeth, that no manner of servant, nor no water-bearer, shall be at the conduit in the service-time, nor leave there no tankard nor pail; for, if they do so offend, the churchwardens shall take the said tankard or pails, and keep them, until such time that the said offenders do come and put into the poorman's chest fourpence, and then the said party to have his tankard again." Some citizens, shut out from the conduits, supplied themselves from the Thames, and even stopped up the lanes leading to the river, suffering none to pass without paying toll. These encroachments were at last checked by complaints to the mayor and aldermen.

The task of inspecting the conduits, confided to the Lord Mayor and Corporation, was, of course,

converted into an annual festival—a procession of civic officers, with the ladies following in waggons. "These conduits," says Stow, "used to be in former times yearly visited; but particularly on the 18th of September, 1562, the Lord Maior Harper, aldermen, and many worshipful persons, and divers masters and wardens of the twelve companies, rid to the conduit's head, for to see them after the old custom. And afore dinner they hunted the hare and killed her, and thence to dinner at the head of the conduit. There was good number entertained with good cheer by the chamberlain; and after dinner they went to hunting the fox. There was a great cry for a mile, and at length the hounds killed him at the end of St. Giles's. Great hallowing at his death, and blowing of hornes; and thence the lord maior, with all his company, rode through London to his place in Lombard-street."

The principal places, or conduit heads, from which the water flowed to the conduits, were Conduit Head, which now forms the site of Conduit-Street, New Bond Street, and several of the adjoining streets, Tyburn, Paddington, White Conduit Fields, Highbury Barn, and Hackney. The spring in White Conduit Fields was destroyed by the Regent's Canal Tunnel, which passes under the New River at Islington and Pentonville. The place where the hunting-party dined, on the occasion of visiting the conduits, was the Lord Mayor's Banqueting House, then situated on a part of the site at present occupied by Stratford Place, Oxford

Street, where a bridge crossed the Tyburn rivulet as it ran through to Tothill Fields. Nine conduits were erected near this bridge in 1238 for supplying the City with water.

These, and many other conduits, failed to satisfy the power of suction existing in the spreading City, and an act of Parliament was obtained by the corporation in 1544, empowering them to bring more water from Hampstead Heath, Marylebone, Hackney, and Muswell Hill. Fifty years elapsed before the objects of this act were fairly realized; but still this was the foundation of the earliest known water company in London. The works and privileges were regularly transferred to a company called the Hampstead Water Company in 1692.

The art of supplying water to towns was in a very rude state until the appearance of Peter Morice, a Dutchman, in 1582, who laid the foundations of the old London Bridge Water Works. He threw water over St. Magnus's steeple, much to the astonishment of the corporation and citizens, who assembled in great crowds to observe the novel experiment; and he was the first man who largely supplied the City with Thames water forced "into men's houses" through leaden pipes. "All the contrivances of the Romans," says Mr. Matthews, "as well as those previously adopted for supplying London, had evidently been formed upon the simple and well-known principle, that water will flow by its natural gravity along any channel that has the slightest inclination downwards. The purpose of

Morice's machinery, however, was to impel the water in an ascending direction, and thus supply places much higher than its usual level. . . . . Although no particular description is given of the means he employed to effect this object, it will be obvious that the use of the forcing-pump accomplished it. This pump was applied to fire-engines in 1663."

Before and after Peter Morice there were many ingenious inventors and daring projectors, but none who succeeded in making their mark upon London like Master Hugh Myddleton.

CHAPTER XIII.

A GREAT PROJECTOR.

JUDGING from what human nature is, and always has been, there must have been much about Master Hugh Myddleton in common with Mr. George Hudson. What the latter did for the extension of railways—what the energetic and unscrupulous Mr. Winsor did for the introduction of gas-lighting—the old Elizabethan speculator did for an improved London water supply. There is a general family likeness amongst all such projectors. They are sanguine men, who leap before they look, and who insist upon making their public leap with them. Their digestion is good; their mental and bodily activity is great, and they give themselves up, for the time, to one idea. They see an endless fountain of wealth, where others can discern nothing but stones and brambles, and they are blind to the many wrecks that strew the coast along which they love to sail. No enterprise which has marked a great stage in the world's progress was ever carried out without the aid of such men, or without a sacrifice on the part of their followers. Time generally softens those angles in the conduct of such projectors which stand out in disagreeable sharpness

before contemporaries, and brings a tardy reward to a later generation, whose task it is to gather what others have sown.

The New River project in 1607 was, without doubt, a most hazardous speculation; a scheme largely forced upon the town in advance of the fair commercial demand, by a man of great self-reliance, plausibility, and energy. It was a scheme which the London corporation of the time—a body not at all wanting in public spirit—refused to carry out, although they had obtained several acts of Parliament to enable them, if they thought proper, to bring water into the City from Hertfordshire. Although the enterprise eventually succeeded, and grew gradually, century after century, into one of the most lucrative of joint-stock undertakings, its commercial character from 1608 up to 1633 is shown to be faulty, from the fact that it paid no dividend for twenty years. The ground it slowly gained afterwards, up to and after the abolition of the conduits in 1728, has been a source of wealth and comfort to the shareholders; but the break-down of Master Hugh Myddleton's golden calculations is hardly concealed by this after success. He was opposed before he undertook the work; he was opposed during its progress; and he was doubtless taunted for years about his unsatisfactory balance-sheets. He retained a sufficient interest in the concern during its financial struggles to make him comparatively wealthy when the turn in affairs arrived—most probably because no one would come

forward to purchase his shares. With singular inconsistency, his memory is cherished by many as that of a great public benefactor, while the existing water companies in general, and his legal representatives in particular, are daily and hourly abused. There is nothing in the dim fragments of his history to prove that he was particularly disinterested in his dealings, or that, beyond painting his enterprise in colours a little too glaring, he carried on his business upon sentimental principles. If Sir Hugh Myddleton, Bart., was really regarded by his contemporaries as it is the fashion to regard him now, it is strange that no one ever stepped forward to write his biography. Before he turned a sod of his new water-channel, he obtained a strictly legal conveyance from the London corporation of all authority vested in them under their several acts of Parliament concerning the water supply. In his dealings with water consumers, after his works were finished, and he was established, with his partners, as a water-seller, he showed no particular sentimental liberality. His bills, no doubt, were punctually delivered; and payment was promptly demanded, on a scale—to judge by specimens preserved in local records—which showed him anxious to get as much money for as little water as possible. In 1616, he granted a lease for twenty-one years to a citizen and his wife of "a pipe or quill of half an inch bore, for the service of their yarde and kitchine, by means of tooe of the smallest swan-necked cockes, in consideration of the yearly sum of twenty-six shillings and eight-

pence." The water then was accused of being muddy, and several rival schemes were put forward by rival speculators.

The work he had to do, and the difficulties he had to surmount, were, no doubt, enormous, and we may give him credit for the skill, industry, and perseverance he displayed, without investing him with purely imaginary qualities. He had to contend against the opposition of certain landed proprietors through whose grounds he wished to cut his channel, and mechanical obstacles which the slender engineering skill of the time scarcely knew how to overcome. This is how the New River came to have its chief beauty—its winding course. He had to petition the corporation for an extension of the time granted him to complete the undertaking; and this being conceded, he brought the water from the springs of Chadwell and Amwell in Hertfordshire as far as Enfield, when he discovered that his funds were exhausted. He again applied to the corporation—this time to induce them to take a pecuniary interest in the concern, or to grant him a loan. Both requests were refused, on account of the great cost of the enterprise, and the uncertainty of its profitable results. In his extremity he applied to King James the First, and succeeded in inducing him to take a half-share in the business, upon condition that the king should pay all the cost of that portion of the work which then remained unexecuted. The firm from that hour became practically Myddleton and James; and they opened as dealers

in water, when the New River entered the reservoir now called the New River Head, in the parish of Clerkenwell, with much music and rejoicing, feasting, processions, and reciting of poems, on the 29th of September, 1613.

Thus was finished one of the most beautiful of artificial rivers; a winding channel forty-eight miles in length, thirty feet deep in many places, spanned by some eight hundred arches in stone and wood, which had employed six hundred men for more than five years. It was disposed of in underground pipes of lead and wood, "serving the highest parts of London in their lower rooms, and lower parts of London in their higher rooms."

CHAPTER XIV.

SUPPLY AND DEMAND.

THE New River—as the whole works are still popularly called—is no more like it was, than the fancy portrait of Master Hugh Myddleton's character is probably like the original. One of the ancient springs—the old Amwell spring—has entirely disappeared, having oozed away silently, about 1830, into the bed of the river Lea. The Chadwell spring, that mysterious, circular, chalky pool, in the Hertfordshire valley, which has been the drinking-fountain for centuries of countless thirsty millions, no longer gives forth drink with its accustomed liberality. Springs, like men, must be allowed to grow weary with work and old age, and must submit to see younger followers rising up to supply their place. The old river channel, winding between flowers and grassy slopes, dipping under roadways, flowing past cottages, churchyards, and country taverns, has had its loops cut off, at different times, until its length has been reduced to something like twenty-eight miles, and it now only counts as one reservoir amongst many. Even the royal partnership was dissolved by Charles the First, who regranted to Sir Hugh Myddleton, then a baronet, the half-share in the undertaking, in consideration of an annual

payment into the Exchequer of five hundred pounds. At this time the chartered enterprise was at very low-water mark, and the act of "royal bounty" may have been a prudent and selfish act, produced by an application—or "call"—on the part of Sir Hugh for more money. The seventy-two parts into which the property is now divided, are still counted as thirty-six "adventurers'," and thirty-six "king's" shares, and the royal annuity is still paid out of the profits apportioned to the latter. It is a curious fact that Myddleton precluded King James from taking any part in the management of the company, although he allowed a person to be present at the meetings, to prevent injustice to his royal principal. This preclusion still extends to the holders of the royal shares. Probably the great water-company projector had no faith in the business talents of kings; or he may have thought that majesty on board days would have shown itself a little too radiant "in the chair." The original cost of the undertaking has to be guessed, because all the documents of the company were destroyed by a fire at their office in Dorset Street, Fleet Street, in 1769. These guesses have varied from five hundred thousand to one hundred thousand pounds sterling; an estimate of one hundred and fifty thousand pounds being, perhaps, nearest to the mark.

The New River Company still holds the first place in the present water system of London. Its sources of supply are the old Chadwell spring, before alluded to; four Artesian wells sunk at Amwell,

Cheshunt, Hampstead Road, and Hampstead Heath; the Cheshunt reservoirs; seven ponds at Highgate, and seven ponds at Hampstead, from which an unfiltered supply is drawn by a separate system of mains for street-watering and like purposes; and the river Lea at Hertford, which now feeds it with the greatest proportion of the water it conveys through London. Its reservoirs, to maintain a stock in hand, are very large and numerous. There are the store and settling reservoirs, consisting of the old river channel, twenty-eight miles long, and perhaps about five yards broad, which has a capacity to store about one hundred and seventeen millions of gallons, or about a day's supply for all London; two reservoirs at Cheshunt, which can store about seventy-five and a half millions of gallons; another reservoir at Hornsey, capable of holding thirty-nine millions of gallons; two more at Stoke Newington, formed in 1833, capable of holding one hundred and thirty millions of gallons; and the ancient "round pond"—the one original reservoir—at the New River head, which contains at least two millions one hundred and sixty-two thousand gallons.

The reservoirs at Stoke Newington are like two vast inland lakes, and their stone-piled borders look like a rocky sea-shore. The engine-house is built to resemble a fortress, and the water, instead of being pumped up pipes that are like gigantic upright trombones, to reach an artificial level, and so supply a point several hundred feet higher than the reservoirs, is forced by the most fearful-looking Cor-

nish engines ever made up into a turret of a watch-tower. Everything has been done to make the artificial look as picturesque as possible; but still the old river channel at the side, with its grassy banks, its overhanging willows, its patient anglers, and the accumulated sentiment of two centuries and a half, is the stream that flows the most readily into our hearts. There is as much difference between the two, as between an ancient footway across the fields, worn into breadth and distinctness by the footsteps of generation after generation, and a new, straight thoroughfare, plastered on each side with stucco, full of right angles, and stamped at every corner with traces of the compass and the rule.

The New River Company, which now includes the old London Bridge Water Company and the older Hampstead Water Company, has eight more store reservoirs for filtered water at different parts of its works, capable of storing about twenty-three and a half millions of gallons. All these reservoirs are covered, with the exception of one at Hornsey, which is exempted on account of its distance from town. The company has eleven filtering beds—three at Hornsey, five at Stoke Newington, and three at the New River Head—possessing a joint sand area of nine and a half acres, and being capable of storing eleven millions one hundred and sixty-three thousand gallons. The filtering medium is five feet in thickness, two of which consist of sand, and the rest of gravel in layers increasing in coarseness towards the bottom. Besides these store

chambers, it has further storage for water supplied for purposes not requiring filtration, in thirteen ponds, before alluded to, at Hampstead and Highgate, which hold about sixty-seven millions of gallons, and one reservoir at Camden Square which holds about two millions of gallons. Summed up roughly, this storage amounts to forty-one reservoirs, counting the river channel as one, having together an area of two hundred and fifteen acres, and holding four hundred and sixty-seven millions of gallons, or water equal to supply the company's district for eighteen days.

There are ten engine-stations at different points of the works, having eighteen engines, possessing together about sixteen hundred horses' power; of which one thousand is at the Green Lanes pumping-station—the castle just described. Besides this, there are several large water-wheels; and the engines and wheels are arranged for the working of fifty-one pumps.

The daily* delivery of water by this machinery is now about twenty-five millions of gallons—nearly one-third of the London water supply—or something like nine thousand millions of gallons annually. Of this yearly quantity, three hundred and fifty millions of gallons are consumed by trades; forty-five millions and a half gallons for flushing sewers, and other sanitary purposes; fifteen millions of gal-

* The phrase "daily" concerning all the water companies' supplies, means six days a week. The Sunday supply is always much smaller.

lons for fires; ninety millions of gallons for street watering; and about eight thousand five hundred millions of gallons for domestic service.

The company's town district has an area of about seventeen square miles; about one hundred and eight thousand houses are supplied; and the highest point to which the water is sent is at Hampstead—four hundred and fifty-four feet above Trinity high-water mark. No water is now drawn from the Thames by this company.

The distribution of this endless stream is made by about six hundred miles of cast-iron pipes, varying in diameter from four feet to three inches; and the tenants' communication lead pipes, which branch out from the mains, must have a joint length of at least fifteen hundred miles. To these underground tubes we must now add about a mile of broad iron tunnel, which has sucked up the New River channel from Sadler's Wells Theatre to the Lower Road, Islington, burying it from the public gaze as an extinct town river, after an honoured existence of two hundred and fifty years.

In all these iron pipes there are about four thousand five hundred sluice-cocks, of diameters varying from three inches to four feet; and about eleven thousand fire-plugs, which have been fixed and are maintained at the company's cost. Water is annually supplied gratuitously to more than a thousand fires, and about one hundred pounds is annually paid by the company in rewards to persons who are first to call turncocks to fires. The capital of this enter-

prise is now nearly two millions and a half sterling, and it gives employment to at least three hundred men.

One water company scarcely differs from another except in the extent of its operations; and the details given respecting the New River and its modern works must be nearly the same in all water-supplying enterprises. On the north side of the Thames, the company that stands next in importance to the New River is the East London, established in 1807, at Old Ford. It represents a capital of one million sterling, and it supplies eighty thousand houses daily with about seventeen millions of gallons of water. Its source of supply is the River Lea, above Tottenham, and its total length of mains and branches may be estimated at about three hundred and eighty miles.

The West Middlesex Waterworks comes next, established in 1806, and its source of supply is now the Thames at Hampton, in Middlesex. Its capital is about seven hundred thousand pounds, and it supplies thirty thousand nine hundred and fifty-two houses with about seven and a half millions of gallons daily. The total length of mains and services for the distribution of this water is two hundred and four miles.

The Chelsea Waterworks, another north side enterprise, was started in 1724, and it now supplies twenty-seven thousand houses with about eight millions and a half of gallons of water every day, drawn from the Thames, at Seething, near Thames

Ditton. Its mains and branches are estimated at about two hundred miles, and its present capital is nearly one million sterling.

The Grand Junction Company—the last on the north-side list—was born in 1798, and its source of supply, originally the Grand Junction Canal, which drew the waters from the rivers Colne and Brent, is now the Thames at Hampton. It distributes about seven millions and a half gallons daily to about eighteen thousand houses; and its capital is nearly three-quarters of a million sterling. The length of its main pipeage is estimated at two hundred and ten miles.

The south side of the river Thames is now provided with three water companies, making, with the five on the north side, eight in all. The Southwark and Vauxhall Company stands first, by reason of its importance. It was started in 1822, and supplies a district originally satisfied by an ancient pond at St. Mary Overies, in Southwark. Its source of supply is the river Thames, at Hampton, and it furnishes ten millions and a half gallons daily, to about forty-two thousand houses. Its capital may be set down as about six hundred and fifty thousand pounds; and its mains and branches are estimated at five hundred and sixty-five miles.

The Lambeth Water Company was founded in 1785, and its capital is now about six hundred and eighty thousand pounds. It supplies thirty-three thousand houses with about seven millions of gallons daily, drawn from the river Thames between

Kingston and Thames Ditton. The total length of the company's main pipes is now two hundred and sixty miles.

Lastly comes the Kent Waterworks, which dates its origin from 1699, and which now includes the Plumstead Company. Its source of supply was originally the river Ravensbourne, but this has been abandoned, and the water is now drawn from Artesian wells. Its capital is three hundred and ten thousand pounds sterling; it supplies twenty-six thousand houses with four and a half millions of gallons daily; and its main pipes are one hundred and sixty-seven miles long. The Plumstead Waterworks, recently purchased by this company, represent a capital of fifty thousand pounds, sixteen miles of main pipes, and a supply of about half a million of gallons a day, drawn from wells in the chalk, to three thousand houses.

These figures and details, which I have taken great pains to collect from the companies themselves, show that the present water supply of London, by the eight existing waterworks, is about eighty-eight millions of gallons daily, sent through about two thousand five hundred and thirty miles of underground main pipes, all changed from wood to iron since 1810. This supply, which consumes a lake every day of sixty acres, six feet deep, flows into some three hundred and sixty-eight thousand houses and tenements *, through about six thousand miles of lead pipes; and the whole present capital of

* Inhabited *houses* (Census, 1861) in London, 362,890.

the water companies is seven millions six hundred and forty thousand pounds. Such a supply of water gives a daily average to each member of our metropolitan population of about thirty-one gallons—although no one really uses more than six gallons a day—at an average cost of about five per cent. on the house rental.

It is surely something, in these times, to be able to lie upon our backs, and, by touching a tap at our own sweet will, to turn a stream into our mouths from Hertfordshire or the other end of Middlesex. The ingenious and powerful mechanism that has helped us to do this is something to be proud of amongst the many wonders of universal trade. If this machinery were to break down, if the sources of supply were to fail, and there was no inducement for keen trading companies to find out fresh fountains in the fruitful earth, our population could not advance another step, and we should wither from the face of the earth. We lie down at night with no misgivings on this head, and we rise in the morning with a full faith that the globe will never be sucked as dry as an exhausted orange. We feel that we are fed by that beautiful law of supply and demand, which can hurl down mountains, or can make a pin; which never fails, except when tinkered full of holes by meddling legislators; and which came from the same Divine will that sends the planets on their course.

CHAPTER XV.

SPIRITUAL MANIFESTATIONS.

EXTRAORDINARY medicinal springs have been discovered in various places at different times, and have been duly subjected to chemical analysis. Science has declared some to be alkaline, chalybeate, or saline, and others to be either carbonated, or flavoured with sulphur. Fashion, rallying round one or other of these springs, has caused "spas" to be built, and has converted quiet inland villages, or obscure London outskirts, into popular watering-places. Fashion, again, either recovered from temporary indisposition, or drawn off by mysterious influence to the worship of new gods, has basely and gradually deserted these places, after raising them into short-lived importance. What has become of St. Chad's Well in the parish of St. Pancras, and of that metropolitan Cheltenham in the High Street of Islington, where Lady Mary Wortley Montagu resorted to "take the waters"? What trace is there now, in the neighbourhood of Sadler's Wells Theatre, of that "New Tunbridge Wells" which Beau Nash honoured with his presence when he could be spared from Bath? A small, mangy "Islington Green" exists, on which it is proposed to

erect a statue to Sir Hugh Myddleton; and a few trees cast their cool shadows across the bonnet-shops and jewellers' windows still forming the one solitary Boulevard in London. This is all. St. Chad's Well —like the old Clerk's Well—is swallowed up by the "Underground Railway" as it passes through King's Cross; and "New Tunbridge Wells" is smothered with the tenements of working watch-makers. However, notwithstanding all this destruction of old springs and their adjuncts, it is possible that every kind of water—even to sea-water—can be obtained in London, either in the wood, the earth, the pipe, or the bottle. Many peculiar metropolitan waters have been found at different times, such as no country wells have ever given forth, and White-chapel has been rendered famous by one of the most curious of these discoveries.

About twenty years ago, in the middle of a very hot summer's day, a respectably-dressed young woman was observed sitting on a door-step in an east-end thoroughfare. Her manner was bewildered, and her speech was incoherent. A policeman coming up in the course of a few minutes, asked her where she lived, and with some little difficulty she told him "the dishtillillery." As there were not half-a-dozen distilleries throughout London, she was supposed to refer to an establishment of the kind in the neighbourhood, and thither she was conducted with as little delay as possible. She was at once recognized and admitted as Mary the housemaid.

There were several theories with regard to the

condition of this housemaid. Charitable people traced it to the heat of the weather; uncharitable people traced it to residence at a distillery. The popular idea was, that in such a place there must be as much gin as water, and that the servants had unchecked liberty to draw either liquor. Some thought it was a pity that steady young women should be thrown in the way of so much temptation; others wished they had the young woman's unlimited control over a spirit tap. Of course the young woman's story, that she had tasted nothing but water, was received with incredulity. Even when she admitted that she had drunk rather freely of the simple fluid, in consequence of the heat of the weather, the incredulity was not lessened. This was one result of living at a distillery.

A few weeks after this occurrence, still in one of the hottest of the summer months, two more of the distiller's female servants were taken unwell. Their illness showed itself chiefly in a tendency to dance and sing songs in a defiant manner, and a disinclination for work. According to their own account, they had tasted nothing but a can of water, and, of course, no one who looked at them believed such a barefaced assertion. Certain symptoms of drunkenness are not easily mistaken, especially when they appear in persons employed at a distillery. The young women were doctored with strong tea, soda-water, and other well-known restoratives, and some care was taken to conceal their indisposition from their employer. This gentleman, however, became

aware of the "accident," as it was called, and very generously took no notice of it. Perhaps, as a distiller, he could hardly object to a little drunkenness, even when it appeared in his own establishment; at least, some of his enemies said as much.

Those who know what a distillery is, could not very reasonably suppose that servants employed in the dwelling-house attached had easier access to the wells of spirit than any stranger passing the outer gate. As the Government has a direct interest in every half-pint of whisky distilled from malt (pure spirit distilled from malt is called whisky), the excisemen have really more control over the premises than the master. These "officers of inland revenue," as they now style themselves, lock up vats, outbuildings, vaults, and coppers, with patent locks, signed and sealed; and the proprietor of the works can only look at his property with the consent of one of these officers. Baths of fiery spirit may be floating underneath the yard or the dwelling-house, but no one can dip a bucket into them, except in the presence of an exciseman. So, those who reflected upon these facts were disposed to be charitable towards the female servants of the distiller.

Nothing more was thought about the matter for some weeks, until a new groom, belonging to the distillery, was heard telling a curious story concerning one of the horses in the stable.

"I giv' 'er 'er feed," he said, "a quartern an' a 'arf an' threepen'orth, which she took as usual; but when I tried 'er with the water, she shied at it. I

thought p'raps the water was dirty, so I empties the pail in the yard, an' fills it agen fresh from the same tap, but when I offered it to 'er she threw up 'er 'ead, an' shook all over."

"What did you do then?" asked one of his listeners, an in-door man-servant, who waited at table.

"What did I do?" returned the ostler, almost contemptuously, "why, tastes the stuff, o' course, an' finds it as good cold whisky-an'-water as I ever put my lips to."

This extraordinary story came to the ears of the master, and the water-tap, which stood in the distillery-yard, was openly examined before all the servants. Water was drawn in tumblers, mugs, and pails, and tasted by all present. No one could detect the slightest flavour of spirit in the liquid, and the ostler, by common consent, was laughed at as a dreamer. He adhered to his story, but his tone was less confident than it had been before the experiment.

A few more weeks passed by, and the story of the temperate horse, who got nicknamed "Father Mathew," began to fade away. Even the excisemen, who were always about the place, although not welcomed as members of the family, and who had taken a strong interest in the groom's narrative, ceased to talk about it. As the weather got much colder, no more mysterious cases of water-intoxication were heard of among the females of the household, and the establishment became as quiet and

well-conducted as the establishments of a dean and chapter in a cathedral city.

Soon after Christmas, however, when the weather was very severe, this calm was broken by a discovery. A spring of water, possessing peculiar properties, suddenly bubbled up in the middle of a public highway in Whitechapel. It was not a saline spring, nor an alkaline spring, nor was it flavoured with sulphur. It was not tested by any people more scientific than a knot of cabmen, boys, and east-end idlers; but one of these bystanders—no mean authority on a question of ardent spirits—boldly pronounced the spring to be "some kind of gin." A fountain of gin spouting up in the middle of the roadway was such a remarkable fact, that no one present could believe it without tasting the liquor. A few hesitated to try the drink, more from fear than from holding temperate opinions; but when a score or two had drunk, and had loudly agreed with the opinion of the first taster, a general scramble for the precious water took place. The mob increased very rapidly, and several wiry boys who had glided in between the men and women, and had taken a fair share of the mysterious fountain, began to show symptoms of youthful intoxication. A few policemen came on the ground, but were unable to dispel the crowd, or account for the mystery. Some few drinkers suggested that charity had something to do with the spring, and that spirits-and-water were being unostentatiously supplied by a friend of the people. This suggestion was rather favourably

received, and the health of the unknown benefactor was noisily drank by the mob, who seemed inclined to take all that the fountain could yield. The policemen had no rule to guide them in such an unexpected emergency, and they only formed part of the mob. Never, since the days when the old water-conduits ran wine on high festivals, was such a scene witnessed in a public thoroughfare.

In the present state of the law and the national finance, it is impossible to cut the connection between excisemen and ardent spirits. Wherever one is seen, the other is sure not to be far off: the spirits following the man, or the man following the spirits. The street-fountain of what turned out to be whisky-and-water was soon taken into custody by a body of inland revenue officers, who had more experience in such matters than the astonished policemen. They tasted the running liquid, and at once began to trace it to its source, unchecked by any theories about remarkable springs. A broken pipe of a well-known east-end water-company was the first thing discovered; and this pipe—burst by the frost—was traced at one end into the distillery where the female servants had made themselves "ill" with "water." The other end of this pipe was also traced, through a long distance, into another distillery, where it may possibly have conveyed whisky underground, without the knowledge of the excisemen, and without volunteering an account to Government. This pipe was ostensibly a private branch water-main, laid down by the two distillers

(who happened to be brothers) to supply their works with water, and no one was more astonished to find the pipe filled with cold "grog" than the suspected manufacturers. One or two scientific men stepped forward in their defence, and discoursed about peculiar waters, and remarkable springs, and several other theories, in explanation of the spiritual manifestations. The Government, however, were not to be satisfied without a trial in a court of law; and a jury, after patiently hearing the case, inflicted a fine of seventy-five thousand pounds sterling on the two distillers. The sobriety of the maid-servants was incidentally vindicated; the ostler was relieved from the suspicion of being a madman; the excisemen were rewarded; the public revenue was benefited; and Whitechapel, in being deprived of a peculiar spring which might have converted it into a "spa," was doubtless the only actual loser.

CHAPTER XVI.

THE GENII OF THE LAMPS.

THERE has been little rest during the present century for underground London. Some road has always been "up" that pipes may be laid down, or tunnels may be constructed. When sewers were not being built, in 1812, the water companies were changing their rotten wooden mains for iron pipes that would bear the pressure necessary for serving their hill customers. Side by side with the workmen of the water companies, were other workmen employed by the then infant gas interest. Coming down to our own days, we have railway tunnels, building or projected, and telegraphic wire-pipes, and "pneumatic despatch" tubes struggling for the few spare feet of underground roadway. Many of our social scientific contrivances in London evidently follow the law of gravitation, and tend towards the centre. It would be easy for some Oriental traveller to turn our Chinese population fables against ourselves, and to show that we have grown too numerous to live upon the surface. By a stretch of fancy, not at all beyond the powers of descriptive travellers, it could be shown that if another man were placed upon this

island, he must necessarily drop off into the sea for want of standing-room.

It would have been a sight worth seeing—a picture worth drawing—the first laying of a gas-pipe in London. The landing of Julius Cæsar, the signing of *Magna Charta*, and the death of Harold, furnish more romantic groupings for historical painters; but no one can say that they were of more historical importance. Civilization took a vast stride on that eventful occasion—the living out-door life of man was lengthened more than one-half; and yet no one was present to give the great work a pictorial record. The Battle of Waterloo was a mere puff of smoke in comparison, for all its deposit of pictures, statues, and treaties.

Of course the workmen were obedient, but sceptical. I can imagine them being very much like the attendant on the alchemists in Teniers's sketch, who holds the crucible over the fire, in the attempt to produce gold, as if it were a vulgar frying-pan, half-full of sausages. It is easy to call such people louts, and to judge them by what we know now, rather than by what was known then; but such louts represent a very wholesome degree of scepticism. For one discovery that has lived through the practical test of application, and has really benefited the world, a thousand have been the pet children of quacks and visionaries. Until the new comer makes good its claim to be considered something beyond the common herd, we save our time, our money, and our labour by regarding it cautiously

The discoverers of gas-lighting had no more than ordinary difficulties to contend with in applying their discovery, and it is fortunate for them that they did not appear three centuries earlier. I am not speaking of Mr. Thomas Shirley, whose "description of a well and earth in Lancashire taking fire by a candle approached to it," in 1667,* is the first known English account of inflammable coal-gas; nor of Dr. John Clayton's accidental discovery of the same fact a few years later, when he constructed the first gas-holder, by inclosing the gas in a bladder; nor of Dr. Richard Watson, who experimented on the same gas in various ways in 1767. I am thinking of Mr. Spedding, who was the first to apply coal-gas escaping from a mine to any economical purpose, by lighting his office at Whitehaven with it about the same period (1767), and who made a proposition to the magistrates to light the town in the same manner. His proposal was simply refused, and little more was said; but had Mr. Spedding lived in the fifteenth instead of the eighteenth century, he would most probably have been tortured as a wizard. Mr. Murdock, the first recorded applier of artificially manufactured gas to house-lighting purposes, who began to use it in Cornwall in 1792, and who seems to have partly purified it from smell and smoke, while lighting Messrs. Boulton and Watt's factory at Birmingham with it, in 1798, was another gentleman who had cause to be thankful to the age he lived in. His illuminations at Birmingham in 1802

* Philosophical Transactions.

would have carried him to the martyr's stake in the bad old days; and his successor, Mr. Winsor, would have been nipped in the bud.

Much abuse has been lavished upon poor Mr. Winsor, because he was not a sound scientific man, and because he was energetic and unscrupulous in carrying out his plans. His science was sufficient to teach him what he had to deal with; and he was the first man to light a London street with gas, and the first to make gas-lighting a branch of commerce. He publicly exhibited his plan of illumination at the Lyceum Theatre in 1803 and 1804; and he lighted up one side of Pall Mall in 1807. His rude lighting was as much an advance upon the old oil-lamps, as those lamps were an improvement upon the old lighting system existing in 1716, when each householder, whose premises fronted any street, lane, or passage, was required to hang out one or more lights every dark night, to burn from six to eleven o'clock, under the penalty of one shilling. His commercial scheme took the form of a National Light and Heat Company, of very extravagant expectations; but it merged at last into the Gaslight and Coke Company, commonly called the Chartered Gas Company, which worked nobly for many years as a pioneer in gas-lighting, without the refreshing taste of a dividend. Few persons, perhaps, who were unlike Mr. Winsor, could have done what he did in the face of so much opposition, grounded on caution and prejudice. While scientific men were playing with the new element in various ways, he helped to mould it into the

basis of a business corporation, and this by unflinching perseverance, devotion to one idea, an absence of sensitiveness, and great oddity of character. Whatever his faults may have been, whatever schemes he may have originally planned for his own enrichment, he clung to his speculation through all its early struggles, and no one has ever shown that he amassed any private fortune. He deceived himself, in his imaginative estimates of profit, as much as he deceived others; and some of his pamphlets are distinguished, not only for their reckless statements, but for the strength and indignation of their tone. "All gas-lights," he says, "shown and exhibited before my illuminating the large theatre in the Lyceum, early in 1804, I fairly consider as so many *Will-o'-the-wisp* lights, known for centuries past. The gas of these lights has been caught and collected in bladders, in marshy ground, the same as all *coal-gas* has hitherto been produced in bladders for philosophical amusement. The principle, that coal and other combustibles contained, among other products, a most beautiful and valuable flame, has been known by the most learned of the last century; but HOW to make the application—HOW to save and analyze—HOW to preserve and refine—HOW to conduct gas in proper air-tight tubes—HOW to introduce gas-fire and gas-lights into a drawing-room, shop, and street-lamp—HOW to cook, melt, boil, and distil by a gas-fire, either in a kitchen or dining-room—HOW to introduce coke, tar, and ammonial liquor for the advantage of a whole nation—HOW to make gas-fire

and gas-lights applicable to light-houses, telegraphs, culinary purposes—in fine, HOW to save and employ all the valuable parts of raw fuel with the greatest possible advantage;—all these most difficult points of my discovery were left a problem to theorists, WHO could *write*, but not *practise*—WHO could fill bladders from retorts, tobacco-pipes, pots, pans, and gun-barrels, with raw smoke, but could not illuminate—WHOSE delicate hands and noses would have shrunk with horror from my numerous dirty and laborious experiments in kitchens and wash-houses, where my own labourers complained of being suffocated, and often refused to assist me, until I shamed them by the example of *stripping* to perform what they thought was too dirty work for them.

"Animated by the life and example of *Peter the Great*, emperor of all the Russias, who performed the most abject labours to teach his ministers and generals how to civilize a barbarous nation, I did no longer deem it beneath me (who had been a merchant in the City of London) to do that work which some of my labourers, actually in want of bread, refused to do for victuals and payment."

Mr. Winsor, with all his pretence of mechanical completeness, never contemplated the erection of a gas-holder, or the storing of a reserve of gas in anything except the main pipes.

It was left for Mr. Clegg, a pupil of Messrs. Boulton and Watt, and the earliest permanent engineer of the Chartered Gas Company, to introduce a variety of mechanical improvements in the manufac-

ture and distribution of gas that have fixed his name in the foremost rank of gas-engineers. In the early days of gas-lighting, the manufacture was very rude, and was long watched with fear by the public and the government inspectors. Sir William Congreve, appointed to make a report on the state of the metropolitan gas-works in 1822, saw two large canvas bags in some works at Whitechapel, of about fifteen thousand cubic feet each, which were for some time used as gas-holders, near to a blacksmith's forge. He hints at the direful consequences which might ensue "were the tar to be discharged and inflamed, like an emission of a large quantity of burning lava from an artificial volcano."

Those black volcanoes, the gas-holders (originally called gasometers), are now vastly increased in size, and improved, until little is left for further alteration. When a deputation from the Royal Society, with Sir Joseph Banks at its head, visited the gas-works of the Chartered Company at Westminster in 1814, they strongly recommended government to prevent the company constructing gas-holders exceeding six thousand cubic feet in capacity, to be confined in very strong buildings. The largest gas-holders in London are now constructed to hold from a quarter of a million to half a million of cubic feet each, and they stand out boldly, like gigantic iron vats, towering above the walls of the gas-yards. The importance of such reservoirs, containing a night's supply of gas in advance, can hardly be overrated by any man who tries to imagine the

condition of London suddenly plunged into total darkness.

The manufacture of gas, although it includes many beautiful scientific processes, is not, on the whole, a sightly operation. What is not seen may be refined and interesting; but what is seen decidedly savours of pandemonium. There are huge caverns of black coal, huge caverns of red-hot coke, and a row of roaring fiery ovens, which sooty men are constantly feeding with coal thrust in out of long iron scoops. The lids of these ovens, or retorts, are generally heated to a white heat, and the men who lift them off and put them on have their hands protected with thick gauntlet gloves. After the coal has been distilled, as it is called, the red-hot coke is raked out, either into coke-vaults, or iron barrows. The spirit of the coal rises up black pipes, like infernal organ pipes, leading from each oven into a tube, running the whole length of the retort-house, called the hydraulic main, which they reach by a curved dip-pipe. The hydraulic main, as its name implies, is half filled with water, and the end of the dip-pipe passes through this water to the depth of about four inches. The gas from the retorts flows down the dip-pipe, and bubbles up by its lightness through the water till it rests in that part of the main above the surface of the liquid, depositing its tar in its progress. The water, which gradually changes its character with this deposit, and becomes nearly all tar, locks the gas in the upper part of the main, and only suffers it to pass off

through the purifiers. These purifiers, partly mechanical, partly chemical, relieve the gas from the vapours of tar, ammonia, sulphuretted hydrogen, and carbonic acid, and allow it to enter the gas-holder or reservoir, pure enough for the ordinary purposes of lighting.

The gas-holder is cylindrical in shape, made of plate iron, covered at the top, but having no bottom. It is inverted over a cistern of water, and both the inlet and outlet pipes for the gas have their mouths above the surface of this water. When the purified gas flows in, it raises the gas-holder, and when it is pressed out into the main pipes, the holder sinks. The gas having a tendency to rise and not to flow, is always sent through the mains by a certain degree of pressure acting on its source.

The London gas supply is now furnished by thirteen gas companies, if we exclude the Brentford, Wandsworth, Crystal Palace district, and the two Woolwich companies, which light only limited portions of the metropolitan area. These thirteen companies—ten on the north side of the river and three on the south side—represent a capital of a little over five millions sterling, and their dividends, on non-preferential shares, have lately shown an average of something like seven per cent. per annum. No trading corporations have been more closely "inspected" by government, and, at present, the regulation of the supply of gas is held to be in the hands of the Home Secretary. "In the year 1829," says Mr. Samuel Hughes, F.G.S., to whom I am indebted for much

information on this subject, "gas was sold in London at fifteen shillings a thousand cubic feet, and at this price it was so impure, that I have seen test-papers, which had been preserved from that date, coloured and stained as black as ink, owing to the presence of sulphuretted hydrogen. At the present day, gas is sold in the City of London at four shillings per thousand cubic feet, without meter rent, and it is so pure that scarcely a trace of sulphuretted hydrogen can be detected in it, and the test-papers for ascertaining this impurity are rarely discoloured in the smallest degree."

We have now, within the metropolitan area, twenty-three gas manufacturing stations, and six gas-holder stations, used solely for storing gas. The total length of mains laid down by the thirteen companies, in underground London, is seventeen hundred and fifty miles, besides about four hundred and fifty miles of branch service-pipes. The house service-pipes, in addition to this, must be at least eight thousand miles long.

The total number of London public street-lamps supplied with gas is thirty-seven thousand seven hundred and twenty-eight, the average distance from each other being seventy-five yards.

The consumption of gas now is at least double what it was ten years ago; and the annual quantity manufactured in London is about eight thousand millions of cubic feet. One-fourth of this quantity, according to reliable estimates, is lost by leakage, condensation, dishonesty, and bad debts; and at

least one half of this fourth—or one thousand millions of cubic feet—escapes every year into the London street earth. Mr. Spencer, the analytical chemist to the New River Company, has traced this escaped gas in its destructive action upon the four thousand seven hundred miles of metropolitan gas and water mains, until underground London appears to be one vast grave of iron rotting into plumbago. The twelve gas-mains, with their eighty joints, which lie side by side with water-mains and telegraphic-wire pipes over the sewers in Cockspur Street, Charing Cross, are not such a happy family as their appearance would lead us to suppose. They are crowded together like tramps in a threepenny bed, and there does not seem to be room for a rat to run between them, but there is no real friendship for all this shaking of hands. The defective joints of the gas-mains lead to the enormous leakage just described, and the escaped gas, by its action on the street earth, destroys water-pipes in a few years that ought to last for a century. Apart from the foul condition of the London street-earth, we are all interested in saving this escaped gas, and this destroyed pipeage, for our gas-bills include the cost of the one, and our water-bills the cost of the other. While the water-pipes are softened, and the gas penetrates the tubes, the water is also adulterated with an undrinkable mixture. I have heard of a letter addressed to a leading water company, which ran somewhat in this form :—

"Mr. Blank presents his compliments to the Blank Company, and wishes to know whether they supply gas or water. Mr. Blank is led to make this inquiry because one of his servants went to the cistern with a pitcher and a candle, and instead of procuring water, she blew up the roof of a wash-house."

This is not a state of things that even poor Mr. Winsor would have been proud of, and it surely cannot be considered beyond a remedy by our present intelligent Genii of the Lamps.

CHAPTER XVII.

UNDERGROUND RAILWAYS.

CERTAIN columns of the "Times" newspaper, at the close of every year, contain the announcements of all those joint-stock companies who are prepared to apply to Parliament in the next session for power to carry out their designs. These long blocks of words are put into the smallest advertising type, are headed with the least attractive of titles, and are drawn up in the driest legal style of English composition. There is nothing in their form or preamble to induce a general reader to examine their contents; and the result is, that projects more revolutionary in their effects upon persons and places than an Indian rebellion or a Parisian riot, are able to give that "preliminary notice" of their birth which is required by parliamentary regulations, without disturbing even the timidest and oldest inhabitant amongst us. Whole parishes are threatened with demolition, venerable churches and landmarks are to be elbowed on one side, half-buried monuments of antiquity are to be ploughed up, like the decayed stump of an old tooth, ground into powder, and scattered to the four winds; the ancient ways upon which our forefathers stood, made bargains, drank, feasted, and

trained their children, are to be deserted, closed, built upon, transformed, or utterly destroyed; grand, gloomy stacks of time-honoured mansions—the traditional abode of kings—the known dwelling-places of old London's merchant-princes—are to be plastered over with the bills of some authorized auctioneer, to be sold as "old rubbish" to the sound of a wooden hammer, to be torn in pieces by eager labourers, who totter on falling rafters, and risk their lives that not a moment of the precious time shall be lost, and to be carted off in a hundred waggons, leaving not a trace behind.

It seems that we are to be allowed no rest from railway engineering operations, until the great idea of a central station in the City of London is made to take material shape. Every railway, at present condemned to have its terminus in the outskirts, is looking wistfully towards that coveted spot within the shadow of St. Paul's, and making signs to its brethren to join hands and help in drawing the circle together. The Eastern Counties Railway is not content to remain at Shoreditch; the Great Western is dissatisfied with Paddington; the North Western and the Great Northern are not happy at Euston Square and King's Cross; the Brighton Railway is discontented with Southwark, although it has stretched out in a roundabout direction, and has succeeded in crossing the river at Battersea, and in reaching Pimlico; the South Eastern has already taken steps to push on to Hungerford Market by the way of the Suspension Bridge, where it expects

to be joined by the South Western Railway, which is fretting down in the hollow of the Waterloo Road; and the Greenwich, Chatham, Southend, and other lines, are all directing their eyes to one common centre. Where this centre will be, yet remains to be seen. At one time public report, as well as engineering projectors, pointed very decidedly to the open space in Farringdon Street, where formerly stood the famous Fleet Prison. That area seems now to be given up, and every eye is turned to Finsbury Circus. This neighbourhood of Greek merchants, institutions, and chapels (if Parliament and railway shareholders prove willing) may become the home of the great central railway station. The project involves connecting lines of railway above and below ground, the appropriation of many existing streets and alleys, and the construction of new thoroughfares. Many people will shake their heads when they hear of this plan; but, while they doubt, the necessary powers and the more necessary capital will probably be obtained, and the work will be begun in as earnest a spirit as that of the "Underground Railway." It is not many months since the public shook its head, and laughed at the idea of a railroad among the sewers. The omnibus and cab interests, as represented by their drivers, were particularly facetious on the subject, forgetting what their predecessors, the stage-coachmen, had predicted of railroads in general, and how signally those predictions had failed.

Much nonsense has been talked about the Metro-

politan Underground Railway, since it began its engineering operations under Mr. Jay and the other contractors; and it is widely supposed that its sole "mission" is to relieve the overcharged road traffic of the City. General observers peep through the long walls of thin boards which inclose its labourers, its shafts, and its engines, and, as they see men descending and ascending to and from the bowels of the earth, they conclude that some wonderful subway is being constructed that will drain off the meat "blocks" of Newgate Street, the carriage "blocks" of Ludgate Hill, and transform London Bridge from a bridge of curses into an agreeable lounge. All this, and more, the Metropolitan Railway may do, through combinations, extensions, and improvements; but, at present, it is merely to be a connecting link between the Great Western, North Western, and Great Northern Railways, which, when constructed and opened about the middle of 1862, will begin at Paddington, and end at Finsbury Circus.

The important centre of the Metropolitan Railway works is at King's Cross, coming within Mr. Jay's contract, which extends from the proposed terminus in Clerkenwell to Euston Square. It is there that the chief and only combined junction on this line is made, out of the City, and it is there that the chief engineering difficulties of the work have arisen.

The main tunnel, running from one terminus to the other, will contain a double line of rails, and it will be twenty-eight feet and a half high, and six-

teen feet and a half broad. The branch tunnels will contain a single line of rails, and be thirteen feet eight inches broad; and fifteen feet high. One of these branch tunnels is now completed,* and it runs up Maiden Lane for about a quarter of a mile, and enters the Great Northern line above the station.

The underground plan at King's Cross, if drawn on paper, would be very much in the form of the letter X standing on a horizontal line. The horizontal line is the main railroad from King's Cross to Paddington, which becomes curved at the junction, and winds towards the City by way of Bagnigge Wells, the House of Correction, and the upper part of New Farringdon Street. The cross, or letter X, goes up from left to right, into the Maiden Lane branch, from the New Road, and comes down from left to right, from the Great Northern Hotel in Old St. Pancras Lane, on to the main line. The lower triangle, formed by the roots of the two oblique lines where they join the horizontal or main line, is filled up with a condemned-cell looking structure, having arched loopholes, in which will be placed the "pointsmen" of the railway, so as to command a view in every direction.

The process of tunnelling under the London streets is very different from a like process in the open country. The material to be penetrated may not be always so hard and unyielding as the rock formations, but it is so full of delicate channels which must not be rudely disturbed, that the labour is

* January, 1861.

rendered twenty-fold more difficult and more expensive. The bed of a London thoroughfare may be compared to the human body—for it is full of veins and arteries which it is death to cut. There are the water-mains, with their connecting pipes; the main or branch sewers, with their connecting drains; the gas-mains, with their connecting pipes, which we have just described; and very often the tubes containing long lines of telegraph wire. If the gravel and clay be opened at any time a few yards under our feet, we catch a glimpse of these tubular channels, lying nearly as close together as the pipes of a church organ. The engineers of the Metropolitan Railway, as we have before said, have had to remove all these old channels to the sides of the roadway, steering their tunnel in between, with the delicacy of a surgical operation. At King's Cross a greater difficulty presented itself in the shape of the old Fleet Ditch. This black Styx of London will often rise six feet in an hour in stormy weather, and its force is particularly felt at King's Cross, which lies at the bottom of the Highgate slope. It was found necessary to divert the course of this unruly stream, and to lock up that portion of its current which flowed through the line the railway was compelled to take. This was done under the personal direction of the able superintendent of the works, Mr. Houselander; but not without many men being kept up nearly a fortnight in wet and mud, night and day, until at last their sewer-boots had to be cut off their legs. The slightest mistake would have flooded the

works, and would have cost Mr. Jay, the contractor, some thirty thousand pounds. The black river is now safely caged, and a large boiler-looking tube, running across the roof at one part of the railway tunnel, carries the Fleet Ditch over the heads of the workmen—and will carry it over the heads of the passengers, as the King's Scholars' Pond Sewer is carried at the Marylebone part of the works.

The inhabitants on each side of the New Road have often travelled upon railways, and have doubtless often wondered how a tunnel was made, and what sort of men they were who made it. An opportunity is now afforded them of learning much upon this subject, without leaving the warm shelter of their drawing-rooms or bed-rooms. A few wooden houses on wheels first make their appearance in the road, and squat, like Punch and Judy shows, at the side of the gutter. A few waggons next arrive, well loaded with timber and planks, and accompanied by a number of gravel-coloured men with pickaxes and shovels. In a day and a night, or little more, a few hundred yards of roadway are inclosed, and a strange quiet reigns for a time, in consequence of the carriage traffic being diverted. The omnibuses that used to form an endless rumbling procession before the windows, are turned down small back streets and winding alleys, while the outside passengers are sometimes nearly rubbed against the houses, or have to stoop to avoid barbers' poles and other trading projections. The calm of the main thoroughfare is soon disturbed by the arrival of

steam-engines, horses, carpenters, and troops of "navvies," within the inclosure. The sound of pickaxes, spades, and hammers, the puffing of steam, and the murmur of voices, begin: never to cease for some months, day or night. Huge timber structures spring up at intervals along the centre of the road, where the spots for opening shaft-holes are marked out, and it is not many hours before iron buckets and chains are at work, dragging up the heart of the roadway. This rubbish is carted off on a tramway as quickly as possible, and tilted down a gaping pit, with a noise like distant thunder, to be carried away into the country along the underground branch railway already completed. Notwithstanding this labour and arrangement, the gravel scatters itself among the houses overlooking the works; the mistresses complain of living in a perpetual "mess," the servants declare their inability to keep door-steps and passages clean in the face of such an earthquake; the front gardens are often trespassed upon, and huge pieces of timber are planted against some of the house to prevent their falling forward into the street. A father of a family looks out of his window one morning after shaving, and finds a large breezy "clearance" among his neighbours' houses to the right or left, which ventilates the neighbourhood, but fills his mind with doubts about the stability of his dwelling. A wet week comes, and the gravel in his front garden turns to clay; the tradespeople tread it backwards and forwards to and from the street door; he can hardly

get out to business, or home to supper, without slipping; and he strongly objects to a temporary way of wet planks, erected for his use, and the use of the passers-by, over a yawning cavern underneath the pavement. Sometimes irritated by seeing his railings broken, and by what he thinks an unwarrantable encroachment upon his liberties as an Englishman, he dreams of Chancery injunctions, and instructs his solicitor to serve all kinds of "notices" on the contractor.

If a wet week, or a wet month, tries the temper of a neighbourhood suffering under the infliction of railway works in the middle of the thoroughfares, it also tries the temper of the contractor. Four or five hundred men have to be paid every Saturday night, although the weather has kept them idle all the week, and the capital invested in plant and machinery is "eating its head off." This latter represents no mean sum, when we have to calculate the value of tunnel supports and scaffoldings at from five to fifteen pounds a yard. The very stuff that we call "dry rubbish," which is thrown on the roadway of a tunnel when it is finished, cannot be bought under six shillings a yard. Luckily, a large contractor has generally too much work on his hands, in different places, to allow him to be idle or melancholy.

This first Metropolitan, or Underground Railway, is now two-thirds completed. From three to four hundred millions sterling of property, invested in English railways, is constantly pressing for an uni-

versal junction throughout the country, and also in London, the heart of the system. An underground railroad, if Parliament be willing, will soon join the Brighton line at Pimlico to Bayswater and the Great Western Railway, by a channel under Kensington Gardens. The Charing Cross branch of the South-Eastern will push on from Hungerford Market to the New Road; thereby attaching itself, through the Underground Railway, with the three great main lines on that side—the Great Northern, North-Western, and Great Western. The Regent's Canal bank will be turned into a railway, and the Great Northern, at King's Cross, will be thus connected with the Eastern Counties' lines. When this is done, the junction of all the metropolitan lines will be effected; and minor branches, such as the one proposed from Smithfield to the Regent's Circus, will merely help to feed the general centralization at Finsbury Circus. These works, like all alterations and repairs, will give employment to many, and be a nuisance to others, as long as they are being constructed; but when the mess is cleared up, and the new channels are thrown open, a sense of comfort and relief will be felt throughout the vast general traffic of London.

APPENDIX

CITY OF LONDON SEWERS.

TABLE showing Difference of Temperature between the Interior of Sewers and the External Atmosphere (in shade).

SUMMARY OF OBSERVATIONS.

TIME OF YEAR.	TEMPERATURE IN EXTERNAL ATMOSPHERE (IN SHADE).			TEMPERATURE IN SEWER.			MEAN TEMPERATURE OF SEWER.	
	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.	Above External Atmosphere.	Below External Atmosphere.
	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.		
Summer	72	55	65·04	68	56	61·92	...	3·12
Winter	34	30	32·37	52	40	43·98	11·61	...
Spring	61	46	52·46	59	48	52·52	0·06	...
Autumn	68	48	59·90	70	53	62·97	3·07	...
Average of Whole Year...	...	...	50·24	...	...	55.35	5·11	...

This Table is the result of observations made by Mr. William Haywood, and is the only table of the kind ever published.

TABLE showing for some of the principal Sewers the Flow of Sewage in Cubic Feet per Day, and also the estimated Flow per Day per Acre drained, and per Head of the Inhabitants of the Area drained in 1857.

NAMES OF SEWERS.	Acres Drained.	Number per Acre.	Assumed Population in District.	Flow of Sewage.	Flow per Acre.	Flow per Head of Assumed Population.
				Cubic feet.	Cubic feet.	Cubic feet.
NORTH SIDE:						
Counter's Creek, Kensington Branch	1,807	23	41,300	353,880	196	8·6
Ranelagh	4,150	32	132,100	924,894	223	7·0
King's Scholars' Pond	1,820	92	167,700	1,203,830	661	7·0
Northumberland Street, Savoy Street, Essex Street, Norfolk Street	633	253	160,000	783,322·5	1,206	4·8
Fleet	4,220	57	239,000	1,741,775	413	7·2
London Bridge	2,250	86	194,750	1,318,830	586	6·4
Ratcliffe Cross	1,098	135	148,230	905,910	825	6·1
The average for the other sewers has not been obtained.						
SOUTH SIDE:						
Effra (Upper)	3,650	7·3	26,850	210,030	57	7·8
Total North Side of Metropolis	31,556	62·	1,963,000	11,513,227	365·	5·9
Total South Side of Metropolis	43,695	16·	693,000	3,736,550	86·	5·4
Total combined	75,251	35·	2,656,000	15,208,083	202·	5·8

TABLE showing the Total Daily Flow in Cubic Feet of all the Sewers in the Metropolitan Area, deduced partly from the Gaugings of the Referees, and partly from the Gaugings made in 1853 by Mr. Bazalgette and Mr. Haywood.

NORTH.			SOUTH.		
Name of Sewer.	Discharge per Day.	Total Discharge per Day.	Name of Sewer.	Discharge per Day.	Total Discharge per Day.
	Cubic ft.	*Cubic ft.*		*Cubic ft.*	*Cubic ft.*
Counter's Creek	353,880		Falcon Brook ...	130,500	
Kensington Sewer					
Ranelagh	924,894		Heathwall ...	390,240	
King's Scholars' Pond ...	1,203,830				
Northumberland Street ...	460,365		Effra, Lower ...	218,235	
Savoy Street	190,140				
Norfolk Street	30,142		Earl	885,600	
Essex Street	102,675				
Ratcliffe Cross	905,910		Duffield	1,002,816	
Limekiln Dock	131,300				2,627,391
Hackney Brook	716,295				
Fleet	1,741,775				
London Bridge	1,318,830		Arnold	169,753	
		8,080,036			
Hammersmith Creek ...			Dover	21,186	
Queen Street, Hammersmith					
Eel Brook			Pudding Mill ...	27,920	
Stamford Bridge					
Old Counter's Creek			Bear	22,373	
Millman's Row					
Church Street, Chelsea ...			Welsh Trooper ..	263	
Queen Street, Chelsea ...					
Smith Street, Chelsea ...			Boar's Head ...	38,968	
Commercial Road, Ranelagh					
Grosvenor Ditch			Black Lion ...	736	
Horseferry Road					
Wood Street	1,128,610		Green Bank ...	11,664	
Victoria Street...					
Whitehall Place			Bridge Yard ...	2,477	
Nightingale Lane, Smithfield					
Union Stairs			Battle Bridge ...	136,550	
Wapping Dock					
New Crane Stairs			St. John's, Great	52,165	
Wapping Wall or King James					
Shadwell Dock Streets ...			Globe	28,404	
Shadwell Dock Stairs ...					
Nightingale Lane, Limehouse			Limekiln ...	33,007	
Great Sluice					
Blackwall Sluice			Rotherhithe Pier	30,807	
Add 55 per cent.* on the above	620,735	1,749,345			
				576,273	
Whitefriar's Dock	61,266				
Paul's Wharf	121,793				
Hambro' Wharf	7,500		Add 23 per cent.* on the above...	132,542	
Dowgate Dock	61,722				
Custom House	38,796				
Ditto East	11,332				708,815
Wool Quay	7,746				
Tower Dock	4,595				
Irongate	132,536		Add, for sewers & small drains, 12 per cent. ...	... ...	3,336,206
		450,286			400,344
		10,279,667			
Add, for sewers & small drains not gauged, 12 per cent. ...	... ...	1,233,560			
TOTAL		11,513,227	TOTAL		3,736,550

* This per centage was obtained by comparing the results of the sewer gaugings of the Referees with Mr. Bazalgette's gaugings of the same sewers.

LIST OF ACCIDENTS WHICH HAVE OCCURRED IN SEWERS.

November 15*th*, 1785. In a branch sewer running from the Irongate Sewer towards the Vine Inn, Bishopsgate Street (there being a dead wall at that spot), in which there was an accumulation of soil and rubbish, the inflammable air took fire and burnt one of the New River Company's workmen.

In *July*, 1823, an explosion of gas took place in a sewer in Mount Street, Grosvenor Square, near South Audley Street, and a workman was so injured as to be confined in St. George's Hospital for six weeks.

August 20*th*, 1824, in Tower Street, a new sewer having been built there, and made temporarily air-tight, two workmen entered for the purpose of removing some centering, when the gas, which had collected, exploded, and they were severely burnt.

July 15*th*, 1826. A bricklayer and labourer were injured by an explosion of gas in a sewer in Praed Street, Paddington.

At the same period the sewer in King Street, Westminster, was found to be in a dangerous state by the gas issuing from the gullies, and it was necessary to make openings in the crown of the sewer in places about a hundred feet apart, for the prevention of accidents, before workmen could enter.

November 27*th*, 1826, an explosion took place in Wood Street and Little College Street, Westminster; the gas escaping from the mains into the sewers, found its way from thence up the private drains of the houses, an explosion took place in the rear of the house of Mr. David Young, of College Street, and communicated with the whole body of gas in the sewer,

the dirt and rubbish being forced out of the gullies in the street by the force.

November 28th, 1831, an explosion took place in Great Queen Street, Drury Lane, when a workman was severely burnt.

November 30th, 1831, an explosion of gas took place in the sewer, Crawford Street, Marylebone, by which the surveyor to the Westminster Commission of Sewers was severely injured.

In 1833, an explosion took place in the man-hole of a new sewer just then built at Peckham.

September 16th, 1833, an explosion of gas took place in Dean Street, St. Ann's, at the corner of Old Compton Street, injuring a person but slightly.

October 16th, 1833, an explosion of gas took place in the house, No. 6, King Street, St. James's Square, occupied by Mr. William Halson; the gas appears to have made its way from the sewer up the drain into the house, and the servant entering the kitchen with a light, it ignited; the room was filled with flame, the woman was lifted to the ceiling by the force of the explosion, which also blew off the skylight over the staircase.

December, 1833, several explosions of a slight character took place in the sewers in Rathbone Place, Oxford Street, which were at that time open.

In 1835, an ignition of gas took place in the Lime Street sewer, and two men were slightly burnt.

In 1836 an ignition took place in the same sewer, and a man was injured.

April 2nd, 1836, two men were injured by an explosion of gas in the sewer in St. Mary Axe.

In 1844, an ignition of sulphuretted hydrogen gas took place in the old sewer in Leadenhall Street.

In 1845, an explosion of coal-gas took place in the sewer in Bride Lane, and a man was burnt.

In 1845, an explosion of coal-gas took place in the sewer in Golden Lane, and a man was burnt.

In 1846, an explosion of coal-gas took place in Fleet Street sewer, and three men were injured.

In 1847, an explosion of coal-gas took place in Holborn sewer, and two men were injured.

In 1849, an explosion of coal-gas took place in Gracechurch Street sewer, and one man was injured.

In *October*, 1849, five men were killed by entering an unventilated sewer in Kenilworth Street, Pimlico; the chemists and analysts examined by the inquest attributed their suffocation to sulphuretted hydrogen.

In 1850, an explosion took place in the sewer in Back Gravel Lane, Pimlico, and one man was injured.

In 1850, an ignition of sulphuretted hydrogen took place in Paternoster Row sewer.

In 1850, an explosion of coal-gas took place in the sewer in Petticoat Lane.

In 1851, an explosion of coal-gas took place in Duke Street, Aldgate sewer, and one man was burnt.

In 1851, an explosion of coal-gas took place in Fore Street sewer, and two men were burnt.

In 1851, an explosion of coal-gas took place in the sewer in Broad Street.

In 1852, by the ignition of sulphuretted hydrogen in an ancient sewer in John Street, Minories, two men were injured.

In 1852, a similar ignition took place during the exploration of an ancient sewer upon one side of Coleman Street.

In *November*, 1852, two men were killed by entering an unventilated sewer in Compton Street, Clerkenwell, owing to the presence of large quantities of sulphuretted hydrogen.

In 1854, an explosion of coal-gas took place in the sewer in Castle Street, Holborn, and a man was burnt.

In 1854, two similar explosions took place in the Threadneedle Street sewer.

In 1855, two similar explosions took place in the Milton Street sewer, and a workman was burnt upon each occasion.

In 1855, an explosion of gas took place in a sewer in Brompton Crescent, Fulham Road.

In *July*, 1855, two of the officers of the Metropolitan Court of Sewers narrowly escaped suffocation whilst engaged in surveying the sewer in Suffolk Street, Southwark.

On 1*st November*, 1855, two flushing men, whilst traversing the sewer in Suffolk Street, Borough, were burnt by an explosion of gas.

In 1856, an explosion of coal-gas took place in the William Street sewer, and one man was injured.

In *August*, 1857, three men were suddenly killed by an escape of carbonic acid gas from a drain into a sewer constructing in the Whitechapel Road.

In 1860, four men were killed in the Fleet Lane sewer, it is supposed by a sudden discharge from some chemical works in the neighbourhood.

SEWER PARLIAMENT.

Parishes each electing Two Members of the Metropolitan Board of Works.

Saint Marylebone.
Saint Pancras.
Lambeth.
Saint George, Hanover Square.
Islington, St. Mary.
Shoreditch, St. Leonard.

Parishes each electing One Member of the Metropolitan Board of Works.

Paddington.
Saint Matthew, Bethnal Green.
Saint Mary, Newington, Surrey.
Camberwell.
Saint James, Westminster.
Saint James and Saint John, Clerkenwell, to be considered as One Parish.
Chelsea.
Kensington, St. Mary Abbot.
Saint Luke, Middlesex.
St. George the Martyr, Southwark.
Bermondsey.
Saint George in the East.
Saint Martin in the Fields.
Hamlet of Mile End Old Town.
Woolwich.
Rotherhithe.
Saint John, Hampstead.

PARISHES UNITED INTO DISTRICTS FOR THE PURPOSES OF THE ACT.

Districts each electing One Member of the Metropolitan Board of Works.

Name of District.	Parishes.	Number of Members to be elected to District Board.	
Whitechapel District	Saint Mary, Whitechapel	27	
	Christchurch, Spitalfields	12	
	Saint Botolph without Aldgate, in the County of Middlesex	6	
	Holy Trinity, Minories	1	
	Saint Katherine, Precinct of	1	
	Mile End New Town, Hamlet of	6	
	Liberty of Norton Folgate	3	
	Old Artillery Ground	1	
	Tower, District of	1	
	TOTAL		58
Westminster District	Saint Margaret	30	
	Saint John the Evangelist	27	
	TOTAL		57
Greenwich District	Saint Paul, Deptford, including Hatcham	21	
	Saint Nicholas, Deptford	6	
	Greenwich	30	
	TOTAL		57
Wandsworth District	Clapham	18	
	Tooting Graveney	3	
	Streatham	9	
	Saint Mary, Battersea, excluding Penge	12	
	Wandsworth	9	
	Putney, including Roehampton	6	
	TOTAL		57
Hackney District	Hackney	51	
	Saint Mary, Stoke Newington	6	
	TOTAL		57

Name of District.	Parishes.	Number of Members to be elected to District Board.	
Saint Giles's District - -	Saint Giles's-in-the-Fields - -	27	
	Saint George, Bloomsbury - -	21	
	TOTAL - -		48
Holborn District	Saint Andrew, Holborn-above-bars - - - - -	24	
	Saint George the Martyr - -	9	
	Saint Sepulchre, in the County of Middlesex - - - - -	6	
	Saffron Hill, Hatton Garden, Ely Rents and Ely Place - -	9	
	The Liberty of Glasshouse Yard -	1	
	TOTAL - -		49
Strand District -	Saint Anne, Soho - - -	18	
	Saint Paul, Covent Garden - -	9	
	Saint John the Baptist, Savoy, or Precinct of the Savoy - -	1	
	Saint Mary-le-Strand - - -	3	
	Saint Clement Danes - - -	15	
	Liberty of the Rolls - - -	3	
	TOTAL - -		49
Fulham District	Saint Peter and Saint Paul, Hammersmith, Fulham - -	24	
		15	
	TOTAL - -		39
Limehouse District - -	Saint Anne, Limehouse - -	15	
	Saint John, Wapping - -	3	
	Saint Paul, Shadwell - - -	6	
	Ratcliffe, Hamlet of - - -	12	
	TOTAL - -		36
Poplar District -	All Saints, Poplar - - -	24	
	Saint Mary, Stratford-le-Bow -	9	
	Saint Leonard, Bromley - -	15	
	TOTAL - -		48
Saint Saviour's District - -	Christchurch - - - -	15	
	Saint Saviour (including the Liberty of the Clink) - - -	24	
	TOTAL - -		39

Districts united for electing One Member of the Metropolitan Board of Works.

Name of Districts.	Parishes.	Number of Members to be elected to District Board.
Plumstead District - -	Charlton, next Woolwich - -	9
	Plumstead - - - -	12
	Eltham - - - - -	6
	Lee - - - - - -	9
	Kidbrooke - - - - -	1
united with	TOTAL - -	37
Lewisham District - -	Lewisham, including Sydenham Chapelry - - - -	24
	Hamlet of Penge - - -	3
	TOTAL - -	27

Parish and District united for electing One Member of the Metropolitan Board of Works.

The Parish of Rotherhithe, united with St. Olave District -	Saint Olave - - - -	13
	Saint Thomas, Southwark - -	1
	Saint John, Horsleydown - -	15
	TOTAL - -	28

To this list must be added three Members elected by the Corporation of the City of London.

SEWER ROUTES.

MAIN SEWERS OF THE METROPOLIS.

NORTH SIDE OF THE THAMES.

Stamford Brook (*West Branch*).—Commences at an angle in the boundary between the parishes of Hammersmith and Acton, on the south of the Uxbridge and London Road, and tangent to a footpath running south from East Acton Lane, extending thence in a south-easterly direction to Paddenswick Green, when it joins the last arm of the said brook.

Stamford Brook (*East Branch*).—Commences at a point on the boundary between the parishes of Hammersmith, Willesden, and Acton, about 100 feet north-east of the Old Oak Bridge over the North Western Railway, extending thence in a southerly direction to Paddenswick Green.

The united streams of the above two branches discharge into Hammersmith Creek.

Brook Green Sewer—Commences in Wood Lane, at the Keeper's Lodge, on the south side of Wormwood Scrubs, and discharges into the River Thames by two outlets, viz., Bridge Road and Queen Street, on the east side of Hammersmith Suspension Bridge.

A branch from the above commences in New Road, at the north end of the Grove, and joins the main sewer at Broadway, Hammersmith.

Fulham Sewer—Commences at a sluice in the moat surrounding the Bishop of London's Palace, on the west side of the junction of High Street, Fulham, with the Fulham Road, and discharges into the Thames under the toll-house of Fulham Bridge.

Eel Brook Sewer—Commences at a point in North End Road, about 80 feet north-west of Walham Green Church, and

discharges into Kensington Canal on the south-east side of the Imperial Gasworks.

Counter's Creek Sewer (*Main Line*).—Commences at a point in the Harrow Road, about 200 feet west of Kensal Green Cemetery Gate, and discharges into the Thames at the outlet now forming on the south-west side of Cremorne Gardens.

Counter's Creek Sewer (*West Branch*).—Commences at a culvert under the Grand Junction Canal, on the boundary between the parishes of Kensington and Hammersmith, at the south-west corner of Kensal Green Cemetery, and joins the above main line in Latimer Road at its junction with Bromley Road.

Counter's Creek Sewer (*East Branch*).—Drains the whole of Kensal New Town, situate in a detached portion of the parish of St. Luke, Chelsea, and part of the parish of St. Mary, Paddington, and passes under the Great Western Railway at a bridge leading to Portobello Lane, on the south-east side of the Western Gasworks, and joins the main sewer at a point about a quarter of a mile north-west of Notting Barn Farm.

Counter's Creek Sewer (*Kensington Branch*).—Commences in Victoria Grove, at about 50 feet to the north of Uxbridge Road, and joins the main line at the junction of Pembroke and Warwick Roads.

Sewer to the Metropolitan Sewage Manure Works.—Commences at Knightsbridge, at its junction with the Ranelagh Sewer, and extends thence in a south-westerly direction to the works at Stanley Bridge.

Millman's Row Sewer.—Commences in Fulham Road, at about 780 feet west, and at about 230 feet east of the junction of Park Walk with Fulham Road, and discharges into the river Thames opposite to Millman's Row.

Church Street Sewer.—Commences in Gloucester Road at its junction with Canning Place, at about 750 feet south of Hogmore Lane Gate, and discharges into the Thames on the south side of Chelsea Old Church.

Queen Street Sewer.—Commences between Gloucester Road and Hyde Park Gate South, on the south of Kensington Road, and about 300 feet south of Kensington Gate runs through Old Brompton, and discharges into the river Thames on the east side of Chelsea Free Dock.

Smith Street Sewer.—Commences in the Kensington Road at a point about 750 feet west of Prince of Wales Gate, and extends thence by Rutland Gate, Rutland Street, and Fulham Road, on the west of Brompton Crescent, and along College and Markham Streets, and discharges into the Thames on the west side of Chelsea Royal Hospital.

Ranelagh Sewer.—The branch sewers from Edgeware Road, Finchley Road, and Kilburn Vale unite at Kilburn Bridge, and for the main line, which, running in a southerly direction, discharges into the river Thames on the south-east side of Chelsea Royal Hospital.

This sewer has several branches, the chief of which commences in Grove End Road, at about 900 feet west of St. John's Wood Road, extending thence by Lisson Grove, New Road, Grand Junction Road, and Albion Street, to a tumbling bay, where it joins the main sewer in Uxbridge Road.

King's Scholars' Pond Sewer.—Commences in the Finchley Road, at about 1500 feet above Junction Road toll-gate, and discharges into the river Thames at the Equitable Gas-works, about 700 feet above Vauxhall Bridge.

King's Scholars' Pond Sewer (Pall Mall Branch).—Commences at Waterloo Place, and joins the main line opposite the entrance of Buckingham Palace.

Grosvenor Ditch.—Commences in Page Street, at about 150 feet east of the junction with Regent Street, Vauxhall Bridge Road, and discharges into the river Thames at the northern extremity of Millbank Road.

Horseferry Road Sewer.—Commences in Grey Coat Place, and discharges into the river Thames at the Horseferry Stairs.

Wood Street Sewer.—Commences in Grey Coat Place,

and discharges into the river Thames in the prolongation of Wood Street.

Victoria Street Sewer.—Commences at Shaftesbury Terrace, Pimlico, and discharges into the Thames at Percy Wharf.

Regent Street Sewer (Western Branch).—Commences in the outer circle of the Regent's Park, at about 200 feet north-west of Hanover Gate entrance, and joins the eastern branch in the New Road, opposite to the prolongation of Portland Place.

Regent Street Sewer (Eastern Branch).—Commences in Upper Albany Street, at about 200 feet south of collateral cut bridge over the Regent's Canal, and joins the western branch at the aforesaid point in the New Road. The main sewer proceeds thence along Regent Street, and discharges into the river Thames at Percy Wharf.

Northumberland Street Sewer (Western Branch).—Commences in Warren Street, on the North of Fitzroy Square, and proceeds in a southerly direction along Cleveland, Newman, Wardour, Princes, and Panton Streets, Haymarket, to Charing Cross, opposite the District Post Office.

Northumberland Street Sewer (Eastern Branch).—Commences in New Road, at about 170 feet west of the junction with Hampstead Road, and proceeds along Tottenham Court Road, High Street, Seven Dials, and St. Martin's Lane, to Charing Cross, when it joins the western branch.

The Main Line proceeds along Northumberland Street, and discharges into the Thames at Northumberland Wharf.

Savoy Street Sewer.—Commences in Stanhope Street, Regent's Park Basin, at a point at about 160 feet north of the junction with Edward Street, and proceeds along Robert, George, Gower, Charlotte, Bloomsbury, Endell, Bow, Wellington, and Savoy Streets, and discharges into the Thames at a point about 100 feet above Waterloo Bridge.

Norfolk Street Sewer.—Commences at the junction of Drury Lane and Long Acre, and passes by the Olympic Theatre, and along Newcastle Street and Strand, and discharges into the river Thames opposite Norfolk Street.

Essex Street Sewer (Western Branch).—Commences in Russell Square, opposite Montague Place, and proceeds along Montague, Russell, and Museum Streets, Drury Lane, Great Wild Street, and Vere Street, to the junction of the eastern branch at the intersection of Sheffield and Gilbert Streets, Clare Market.

Essex Street Sewer (Eastern Branch).—Commences at the corner of Tottenham Court Road, and proceeds along New Oxford Street, Newton Street, and Cross Lane, Parker and Great Queen Streets, west side of Lincoln's Inn Fields, to the junction with the western arm above described.

The Main Sewer proceeds thence along Gilbert Street, Clement's Lane, Pickett Street, and Essex Street, and discharges into the river Thames at Temple Pier.

Fleet Sewer.—Commences in High Street, Hampstead, at the junction of High Street with Flask Walk, extending thence through South End Green, Gordon House Lane, Victoria Road, Great College Street, Old St. Pancras Road, Bagnigge Wells Road, West of Middlesex House of Correction, and by Farringdon Street to Blackfriar's Bridge, where it discharges into the river Thames.

This sewer has numerous tributaries running into other districts, the chief of which are Camden Road, Caledonian Road, Pentonville Hill, River Street, St. John's Road, Holborn Hill, and Guildford Street.

Goswell Street Sewer.—Commences in Sydney Street, at the junction of Sydney Grove, and discharges into the Thames at Walbrook.

London Bridge Sewer (City Road Branch).—Commences at Duncan Terrace, on the west side of the New River, and joins the main line at the north end of Finsbury Pavement.

Another branch commences in Lonsdale Square, Islington, and, extending thence through Barnsbury Street, Richmond Grove, passes under the New River at New North Road Bridge, thence along Portland Place, King Street, under the Regent's Canal, by Sturt's Lock, Walbrook Street, and

Critchill Place, where it joins another branch at St. John's Church, Hoxton.

London Bridge Sewer (*Ball's Pond Branch*).—Commences on the boundary between St. Mary, Islington, and St. John, Hackney, at Cock and Castle Lane, Dalston, and passes by Ball's Pond and Rosemary Branch Bridge to the Junction at St. John's Church, above described. The united sewers then discharge into the river Thames at London Bridge.

London Bridge Sewer (*Shoreditch Branch*).—Commences in Queen's Road, at the junction with Laurel Street, Dalston, and extending thence along Queen's Road, Great Cambridge Street, Hackney Road, Shoreditch, and Bishopsgate, joins the main line at King William's Statue.

Irongate Sewer.—Commences in the City, and proceeds along the south-west side of Houndsditch, west side of Minories, and by the precincts of Old Tower Without, and discharges into the river Thames at Irongate Stairs, on the east of the Tower.

Nightingale Lane Sewer.—Commences in Union Street, Old Artillery Ground, and Booth Street, Spitalfields, and extends thence along Commercial, Leonard, Wells, and Parson Streets, and Nightingale Lane, and discharges into the Thames on the western side of the entrance into Hermitage Basin.

Hermitage Street Sewer.—Commences in Redmead Lane, on the boundary between the parishes of St. John, Wapping, and St. George-in-the-East, and extends thence along Great Hermitage Street, and discharges into the river Thames at about 50 feet east of Union Stairs.

Old Gravel Lane Sewer.—Commences at the boundary between the parishes of St. George-in-the-East and St. John, Wapping, in Old Gravel Lane, and discharges into the river Thames at a point about 110 feet west of the Thames Tunnel.

Wapping Wall Sewer.—Commences in Green Bank, at the junction of Upper Well Alley, and passes through King Street, and discharges into the river Thames at about 120 feet on the north-east side of New Crane Dock.

Shadwell Basin Sewer.—Commences on the north side of the Eastern Dock, at the termination of West Gardens, and extends thence between the warehouses and New Gravel Lane, on the north side of Shadwell Basin, and along Shadwell Dock Street, and discharges into the river Thames at the eastern pier of the Shadwell entrance to the London Docks.

Pennington Street Sewer.—Commences at the boundary between the parishes of St. George-in-the-East and St. John, Wapping, in St. George Street, and extends thence along Pennington Street, Old Gravel Lane, West Gardens, Cow Lane, Little Spring Street, Labour-in-vain Street, and Lower Shadwell, and discharges into the river Thames at Shadwell Dock Stairs.

Ratcliffe Highway Sewer (Western Branch).—Commences at the junction of Sherwood Place with Meed Street, at about 900 feet south-east of Shoreditch Church, and extends along Turvile, Thomas, and High Streets, and Whitechapel Road, to the Junction of New Road with Whitechapel Road.

Ratcliffe Highway Sewer (Eastern Branch).—Commences at the junction of Hague Street with Bethnal Green Road, and extends along Hague Street, Wellington and Charles Streets, to the junction of New Road with Whitechapel Road, above described.

Ratcliffe Highway Sewer (North-eastern Branch).—Commences from the rear of Shoreditch Church, and proceeds along Old Castle Street, Virginia Row, Wellington Row, Old Bethnal Green Road, Cambridge Road, Cleveland Street, King Street, Jamaica Street, Havering Street, and Love Lane, to Ratcliffe Highway.

The Main Sewer proceeds along New Road, Cannon Street Road, St. George's Street, High Street, Shadwell, and Broad Street, and discharges into the river Thames at Ratcliffe Cross Stairs.

Limekiln Dock Sewer.—Commences at the junction of Victoria Road with Bishop's Road, on the south-western side of Bonner's Hall Bridge, leading into Victoria Park, and ex-

tends along Victoria Road, east side of Bethnal Green, Globe Road, White Horse Lane, and Rhodeswell Road, and passes under the Regent's Canal at Rhodeswell Wharf, thence along the Black Ditch, Upper North Street, and North Street, and discharges into the river Thames at Limekiln Dock.

Great Sluice and Drunken Dock Sluice.—These sluices are situated on the eastern side of the Isle of Dogs, and drain the whole of that part of the isle south of the West India Dock Basin. They have four inlet sluices for purposes of flushing.

Blackwall Sluice.—Commences at Batson's Inlet, near Limehouse entrance to the West India Dock, and discharges into the Thames on the north side of the Blackwall entrance to the West India Dock.

Eastern Counties Railway Sewer.—Commences at Mile End Bridge, over the Regent's Canal in Bow Road, proceeds along Bow Road, Tredegar Square, and by the railway, and discharges into the river Lea, where the viaduct of the said railway crosses that river.

Hackney Brook Sewer (*Main Line*).—Commences in the high road opposite to St. John's Church, Upper Holloway, and extends thence in a south-east direction along Holloway Road to a point about 450 feet south of Tollington Road, thence in an easterly direction by the north of Abney Park Cemetery, Hackney Downs, and Hackney Wick, and discharges into the river Lea, immediately to the north of Old Ford Wharf.

Hackney Brook Sewer (*Wick Lane Branch*).—Commences in Old Ford Road, on the east side of Old Ford Bridge, crossing the Regent's Canal, and extends along Grove Road, Wick Lane, and joins the main sewer at Hackney Wick.

SOUTH SIDE OF THE THAMES.

Beverley Brook.—Commences on the boundary between the parishes of Putney and Wimbledon, at a point about 1800 feet south of Beverley Bridge, on the Kingston Road,

and discharges into the river Thames about half a mile above Putney town.

Sewer between Parishes of Putney and Wandsworth.—Commences on the road from Kingston to Wandsworth, and discharges into the river Thames at a point about 1500 feet below Fulham Bridge.

Wandle River.—Commences at a point where the parishes of Streatham and Tooting intersect the river, and discharges into the river Thames at the town of Wandsworth.

Falcon Brook.—Commences at Tooting Common, and discharges into the river Thames at Battersea Creek.

Lord Spencer's Sewer.—Commences in the town of Battersea, and extends in an easterly direction through Battersea Park, and discharges into the river Thames at about 400 feet below Battersea New Bridge.

Heath Wall Sewer (Main Line).—Commences at the Falcon Brook at a sluice about 300 feet north of the South Western Railway, and extending along the south margin of Battersea Fields, discharges into the Thames at Heath Wall Mill.

Heath Wall Sewer (Clapham Rise Branch).—Commences on the boundary between the parishes of Clapham and Lambeth at the intersection of New Road with Clapham Rise, and extends along the east side of Clifton Street, and joins the main sewer at a point about 100 feet north-east of New Road, Battersea Fields.

Effra Sewer.—Commences at the boundary between the parishes of St. Mary, Lambeth, and Croydon, in Westow Hill Road, immediately opposite to the convent of "Our Lady," and discharges into the river Thames at Vauxhall Creek, on the south side of the Phœnix Gasworks, and near to Vauxhall Bridge.

Effra Sewer (Upper Norwood Branch).—Commences in Westow Hill Road on the boundary between the parishes of Lambeth and Croydon, at about 200 feet west of the Crystal Palace Hotel, and proceeds northward along the boundary between the parishes of St. Mary, Lambeth, and St. Giles's,

Camberwell, and joins the main sewer at a point about 230 feet west of Croxted Lane.

Duffield and Battle Bridge Sewers.—These sewers drain the most densely inhabited portions of the south side. The inlets for flushing purposes are at Kennington, Vauxhall, Lambeth Church, and Stangate. The outlets are by the following sluices, viz., the Arnold and Dover Sluices, near Waterloo Bridge; Pudding Mill, near Blackfriar's Bridge; the Boar's Head, Welsh Troopers, Black Lion, and Bear Sluices, near Southwark Bridge; the Bridge Yard, Battle Bridge; and Green Bank, in St. Olave, Southwark; Freeman's Lane, St. John Jerusalem; and Great St. John, in Horsleydown; and the Salisbury and Duffield Sluices, in Bermondsey.

Limekiln Sluice.—Drains the open fields of part of the parish of Rotherhithe, and proceeds along Swan Lane, and discharges into the river Thames at about 300 feet east of the Thames Tunnel.

Globe Stairs Sewer.—Drains the northern basin of the Commercial Dock Company, and extends along the eastern side of St. Paul's Church, Rotherhithe, and part of Rotherhithe Street, and discharges into the river Thames at Globe Stairs.

Sewer at Durand's Wharf (Rotherhithe).—Commences to the south-east of Bull Head Dock, Rotherhithe, and pursues an easterly course by Rotherhithe and Lower Queen Street, and discharges into the river Thames at a "10 Footway," opposite to Cow Lane.

Rotherhithe Pier Sewer.—Commences in Trinity Street, at a point about 400 feet south of Cow Lane, and proceeds along Trinity Street, and discharges into the river Thames at Rotherhithe Boat Pier.

Earl Sewer (Main Line).—Commences in Cold Harbour Lane, at a point about 1100 feet north-east of its junction with Loughborough Road, and proceeds along High Street, Camberwell, Camberwell Road, Boundary Lane, and eastward along the boundaries of several parishes, and discharges

into the river Thames on the boundary between the counties of Surrey and Kent, near to the Royal Dockyard, Deptford.

Earl Sewer (*Wyndham Road Branch*).—Commences on the east side of Kennington Park, and proceeds along New Row, and southward on the east of Thomas Street, eastward along Wyndham Road, and joins the main sewer at a point about 100 feet south of Southampton Street, Camberwell.

Earl Sewer (*White Post Lane Branch*).—Commences in Victoria Road, at the junction with Choumert Place and Cutthroat Lane, near Peckham Rye, and proceeds along Victoria Road, Hanover Street, Rye Lane, High Street, Meetinghouse Lane, Halfway House Lane, and White Post Lane, and joins the main sewer at the junction of the parishes of Rotherhithe, St. Paul's, Deptford, and St. Giles's, Camberwell.

Royal Dockyard Sewer.—Commences on the east of Black Horse Bridge, and extends eastward on the south side of the Mast Pond, and discharges into the river Thames opposite to the Royal Victualling Yard.

Ravensbourne and Sydenham Sewer.—Commences at Bell Green, and extends along and by Catsford Hill Road, Lewisham, and Bromley Road, Silver Street, Loam Pit Vale, and Mill Lane, and discharges into Deptford Creek at Parish Wharf, near Kingsford Mill.

Ravensbourne and Lee Green Sewer.—Commences in the Eltham Road, about 300 feet east of Lee Green, and proceeds along Lee Road, Lewisham Road, Bath Place, Egerton Road, and North Pole Lane, to a pumping station, where it discharges into Deptford Creek, at a point about 400 feet north of the London and Greenwich Railway.

Horseferry Road (*Greenwich*).—Commences in Caroline Street and Roan Street, and proceeds along Union and Bridge Streets, and discharges into the river Thames at Horseferry.

THE THAMES EMBANKMENT.

THE Commission appointed to consider the Thames embankment question have sent in the following report:—

"TO THE QUEEN'S MOST EXCELLENT MAJESTY.

"We the undersigned members of your Majesty's Commission, appointed to examine into plans for embanking the river Thames within the metropolis, so as to 'provide with the greatest efficiency and economy for the relief of the most crowded streets, by the establishment of a new and spacious thoroughfare for the improvement of the navigation of the river, and which will afford an opportunity of making the low-level sewer without disturbing the Strand or Fleet Street, and also to report upon the cost and means of carrying the same into execution,' now humbly submit to your Majesty the conclusions at which we have arrived, and the recommendations we have agreed to offer.

"2. The nature of the inquiry intrusted to us was made known to the public by advertisement in the newspapers, and more than 50 designs were presented for our consideration.

"3. The main features of the majority of the plans are an embanked roadway on the north side of the river, and the formation of docks with the view to retain all the existing wharves; in others, railways, in addition to the roadway and docks, have been proposed; while, in a few, a solid embankment and roadway without either docks or railways have been suggested. Among these latter is a plan submitted by Mr. Shields, some of whose suggestions appear to us to afford, in a greater degree than any of the other designs, the basis upon which an efficient and economical scheme may be founded. We desire, however, to express our high appreciation of the great engineering skill and

ability that have been displayed in many of those designs which contemplated the construction of docks and railways.

"4. The wharf property between Westminster Bridge and the Temple Gardens is for the most part devoted to the coal trade. We find that great facilities are now afforded for the distribution of coal by the new system of unshipping in the docks into railway waggons, and by various depôts on the railways in and near the metropolis. We are of opinion that public convenience no longer necessitates the continuance either of the coal or any other trade in this immediate locality. We therefore think that it would not be expedient to construct and maintain docks for the sake of preserving the existing wharves between the points we have mentioned; while their removal will greatly simplify the formation of the embankment, and add to the beauty of the river. The wharf property, however, between the Temple Gardens and Blackfriar's Bridge cannot, in our opinion, be so treated; and that eastward of Blackfriar's Bridge is so important in a commercial point of view that we do not recommend any interference with it.

"5. Having regard to these and other considerations, we are of opinion that we shall best fulfil your Majesty's instructions, and provide for the requirements of the public, by establishing a spacious thoroughfare between Westminster Bridge and Blackfriar's Bridge by means of an embankment and roadway; and that the new thoroughfare thus created should be continued on eastward from Blackfriar's Bridge by a new street, according to the line formerly laid down by Mr. Burning, the City's architect, from the west end of Earl Street, across Cannon Street to the Mansion House. Without such a street no relief whatever would be given to the crowded thoroughfares of Ludgate Hill, St. Paul's Churchyard, and Cheapside.

"6. The line of embankment at Westminster would coincide with the terrace of the Houses of Parliament, and thence to Blackfriar's Bridge would nearly follow the line

laid down for the Corporation of the City in 1841, by Mr. Walker, Captain Bullock, Mr. Saunders, and Mr. Leach. The general level of the embankment and road would be 4 feet above Trinity high-water. The road would commence at Westminster by an easy descent opposite the Clock Tower, and be continued on, 100 feet in width, to the eastern boundary of the Temple Gardens; from this point the road would be reduced to 70 feet in width, and carried on a viaduct supported by piers of masonry, rising to the level of Blackfriars Bridge, so constructed as to leave a breadth of water for the convenience of the City Gasworks and the adjoining wharves of about 70 or 80 feet. The spaces between the piers under the ascending road would be left available for barges to lie, and afford easy access to the water between this structure and the wharves.

"7. From Westminster Bridge to the eastern boundary of the Temple Gardens, the embankment—sustained by a river wall—would be solid in its whole breadth; which breadth opposite Richmond Terrace would be 220 feet from the existing river wall. At Hungerford it would be 320 feet from the existing wharf; at Somerset House about 120 feet, and at the Temple about 220 feet. The plan accompanying this report sets forth the entire scheme.

"8. With respect to the appropriation of the reclaimed land, we would recommend that so much of it as shall be in front of the Crown property—which will be about 120 feet in width in its narrowest part—should be laid out in ornamental gardens for the accommodation of the occupiers of the houses, and that the portion in front of the Temple Gardens, also about 120 feet wide, be placed at the disposal of the Society, to be dealt with in a similar manner. The other portions of the reclaimed land may either be kept open for the health and recreation of the public, or be applied to building purposes.

"9. We propose that communications should be made with the intended roadway from Whitehall, opposite the Horse Guards, and also from some of the streets in the Strand—

and that a new street should be formed, passing through the Savoy to Wellington Street. The frontages on these streets, would offer eligible sites for building, as would also the inner frontage of the new road, if it should hereafter be thought fit so to utilize the ground. We, however, feel it our duty to recommend that while economy and utility in laying out and disposing of the ground should be kept in view, endeavours should be made to invest this new and conspicuous work with some elements of interest and beauty.

"10. For the improvement of the navigation we recommend that the existing shoals between Waterloo and Westminster bridges should be removed, due regard being had to the foundation of the former. Also that an uniform low-water channel of six feet in depth at ordinary spring tides, and 500 feet in width from the embankment wall, be secured, and thus the stream be more equalized in velocity. If at any future time any effect should be produced on the river from the diminution of its capacity for tidal water by reason of the embankment, arrangements may be made higher up the river by dredging, or by a tidal reservoir, to compensate for the loss. The consideration, however, of this matter would naturally devolve on the Conservators of the River Thames.

"11. The embankment and street we have proposed will afford an opportunity of making the low-level sewer without disturbing the Strand or Fleet Street, and at the same time facilitate the construction of the sewer eastward of the embankment.

"12. We are not prepared to recommend the construction of an embankment on the Surrey shore at present, but if hereafter it should be thought desirable or necessary to embank any portion of it, the scheme we have proposed for the Middlesex side will not in any way interfere with it.

"13. With regard to that part of our instructions in which we are commanded by your Majesty to 'report on the costs and means of carrying the same into execution,' we

beg to report that we estimate the cost of the land, making compensations, constructing the embankment and roadways, and also acquiring the property in the City for and forming the new street to the Mansion House, at £1,500,000. This amount, however, would be reduced should it be thought right to dispose of any of the reclaimed land on the bank of the river for building purposes,

"14. Parliament having appropriated the coal dues to provide for the outlay necessary for this great work, it only remains for us to express our opinion as to the 'means of carrying the same into execution.'

"15. Looking at the magnitude of the work, the important and varied interests, both public and private, which will be affected—and the urgent necessity for its early completion—we are of opinion that the control and management of the undertaking should be intrusted to a special commission, appointed by your Majesty, in order to insure the speedy and economical attainment of an object so much needed by the public, and affording so favourable an opportunity for the improvement of the river and adornment of the metropolis.

"All which we humbly report to your Majesty.

"Witness our hands and seals this 22nd day of July, 1861.

"William Cubitt. "Edw. Burstal.
"Joshua Jebb. "Henry A. Hunt.
"Douglas Galton. "John Robinson M'Clean.
"Henry Kingscote, *Secretary*."

HEADS AND HOUSES.

TABLE VIII. of the late Census, giving the Number of Houses and Population in the principal Cities and Boroughs having defined municipal or parliamentary limits, states the Population of London to be 2,803,034 in 1861, as against 2,362,236 in 1851; inhabited houses in 1861, 362,890; in 1851, 305,933.

Under the return of Houses and Population in the Superintendent-Registrar's districts on March 31st, 1851, and on April 8th, 1861, the London division shows the subjoined results:—

	Population Enumerated.		Increase or Decrease in the Number of Persons between 1851 and 1861.	
	1851.	1861.	Increase.	Decrease.
MIDDLESEX (part of).				
Kensington	120,004	186,463	66,459	—
Chelsea	56,538	63,423	6,885	—
St. George, Hanover Square	73,230	87,747	14,517	—
Westminster	65,609	67,676	2,067	—
St. Martin-in-the-Fields	24,640	22,636	—	2,004
St. James, Westminster	36,406	35,324	—	1,082
Marylebone	157,696	161,609	3,913	—
Hampstead	11,986	19,104	7,118	—
Pancras	166,956	198,882	31,296	—
Islington	95,329	155,291	59,962	—
Hackney	58,429	83,295	24,866	—
St. Giles	54,214	53,981	—	233
Strand	44,417	42,956	—	1,461
Holborn	46,621	44,861	—	1,760
Clerkenwell	64,778	65,632	854	—
St. Luke	54,055	56,997	2,942	—
East London	44,406	40,673	—	3,733
West London	28,833	27,144	—	1,689
London City	55,932	45,550	—	10,382
Shoreditch	109,257	129,339	20,082	—
Bethnal Green	90,193	104,905	14,712	—
Whitechapel	79,759	78,963	—	796
St. George-in-the-East	48,376	48,878	502	—
Stepney	54,173	56,567	2,394	—
Mile End Old Town	56,602	73,064	16,462	—
Poplar	47,162	79,182	32,020	—
SURREY (part of).				
St. Saviour, Southwark	35,731	36,026	295	—
St. Olave, Southwark	19,375	19,053	—	322
Bermondsey	48,128	58,355	10,227	—
St. George, Southwark	51,824	55,509	3,685	—
Newington	64,816	82,157	17,341	—
Lambeth	139,325	162,008	22,683	—
Wandsworth	50,764	70,381	19,617	—
Camberwell	54,667	71,489	16,822	—
Rotherhithe	17,805	24,500	6,695	—
KENT (part of).				
Greenwich	99,365	127,662	28,297	—
Lewisham	34,835	65,752	30,917	—

The following shows the increase (or decrease) in the number of inhabited houses and in the population in the several metropolitan and suburban districts:—Kensington—houses in 1851, 17,151; in 1861, 25,854; population in 1851, 120,004; in 1861, 186,463. Chelsea—houses in 1851, 7591; in 1861, 8318; population in 1851, 56,538; in 1861, 63,423. St. George, Hanover Square—houses in 1851, 8792; in 1861, 10,421; population in 1851, 73,230; in 1861, 87,747. Westminster—houses in 1851, 6642; in 1861, 6880; population in 1851, 65,609; in 1861, 67,676. St. Martin-in-the-Fields—houses in 1851, 2307; in 1861, 2283; population in 1851, 24,640; in 1861, 22,636. St. James, Westminster—houses in 1851, 3399; in 1861, 3331; population in 1851, 36,406; in 1861, 35,324. Marylebone—houses in 1851, 15,826; in 1861, 16,370; population in 1851, 157,696; in 1861, 161,609. Hampstead—houses in 1851, 1719; in 1861, 2653; population in 1851, 11,986; in 1861, 19,104. Pancras—houses in 1851, 18,584; in 1861, 21,928; population in 1851, 166,956; in 1861, 198,882. Islington—houses in 1851, 13,528; in 1861, 20,676; population in 1851, 95,329; in 1861, 155,291. Hackney—houses in 1851, 9818; in 1861, 13,412; population in 1851, 58,429; in 1861, 83,295. St. Giles's—houses in 1851, 4700; in 1861, 4662; population in 1851, 54,214; in 1861, 53,981. Strand—houses in 1851, 3949; in 1861, 3815; population in 1851, 44,417; in 1861, 42,956. Holborn—houses in 1851, 4311; in 1861, 4125; population in 1851, 46,621; in 1861, 44,861. Clerkenwell—houses in 1851, 7224; in 1861, 7086; population in 1851, 64,778; in 1861, 65,632. St. Luke—houses in 1851, 6349; in 1861, 6368; population in 1851, 54,055; in 1861, 56,997. East London—houses in 1851, 4739; in 1861, 4495; population in 1851, 44,406; in 1861, 40,673. West London—houses in 1851, 2670; in 1861, 2616; population in 1851, 28,833; in 1861, 27,144. London City—houses in 1851, 7297; in 1861, 6367; population in 1851, 55,932; in 1861, 45,550. Shoreditch—houses in 1851, 15,337; in 1861, 17,231; population in 1851, 109,257; in 1861, 129,339. Bethnal Green—houses in 1851,

13,298; in 1861, 14,812; population in 1851, 90,193; in 1861, 104,905. Whitechapel—houses in 1851, 8812; in 1861, 8667; population in 1851, 79,759; in 1861, 78,963. St. George's-in-the-East—houses in 1851, 6146; in 1861, 6187; population in 1851, 48,376; in 1861, 48,878. Stepney—houses in 1851, 7392; in 1861, 7465; population in 1851, 54,173; in 1861, 56,567. Mile End Old Town—houses in 1851, 8867; in 1861, 10,768; population in 1851, 56,602; in 1861, 73,064. Poplar—houses in 1851, 6831; in 1861, 11,163; population in 1851, 47,162; in 1861, 79,182. St. Saviour, Southwark—houses in 1851, 4600; in 1861, 4495; population in 1851, 35,731; in 1861, 36,026. St. Olave, Southwark—houses in 1851, 2360; in 1861, 2214; population in 1851, 19,375; in 1861, 19,053. Bermondsey—houses in 1851, 7007; in 1861, 8211; population in 1851, 43,128; in 1861, 58,355. St. George's, Southwark—houses in 1851, 6992; in 1861, 7234; population in 1851, 51,824; in 1861, 55,509. Newington—houses in 1851, 10,458; in 1861, 12,815; population in 1851, 64,816; in 1861, 82,157. Lambeth—houses in 1851, 20,447; in 1861, 23,001; population in 1851, 139,325; in 1861, 162,008. Wandsworth—houses in 1851, 8276; in 1861, 11,136; population in 1851, 50,761; in 1861, 70,381. Camberwell—houses in 1851, 9412; in 1861, 12,122; population in 1851, 54,667; in 1861, 71,489. Rotherhithe—houses in 1851, 2792; in 1861, 3529; population in 1851, 17,805; in 1861, 24,500. Greenwich—houses in 1851, 14,383; in 1861, 17,826; population in 1851, 99,365; in 1861, 127,662. Lewisham—houses in 1851, 5,927; in 1861, 9701; population in 1851, 34,835; in 1861, 65,752.

THE END.

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